CHILD DEVELOPMENT

VOLUME 11

MARCH, 1940 to DECEMBER, 1940

KRAUS REPRINT CO.
Millwood, New York
1975

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The Society for Research in Child Development, Inc.

KRAUS REPRINT CO.
A U.S. Division of Kraus-Thomson Organization Limited

PRINTED IN THE UNITED STATES OF AMERICA

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NUTRITIONAL STATUS OF SCHOOL CHILDREN IN A SMALL INDUSTRIAL CITY[1]

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As a part of a long-time study in human nutrition begun in 1935 by the Division of Home Economics Research at The Pennsylvania State College for the purpose of finding the dietary habits and the nutritional status of persons of different ages and socio-economic types, the study reported herein was carried on in December, 1936, and January, 1937.

SUBJECTS

The subjects of the study were children in a city of about 82,000 inhabitants, in which industrial activity, centered around extensive railroad shops, had been relatively limited for a number of years. The children, 428 in number, were selected from the 28 grade schools of the city in such a way as to give distribution with respect to the occupation and income of their respective parents comparable with that of the community as a whole. Three per cent of the children came from families with a cash income of $2500 and over; 47.4 per cent from $2499 to $1000; and 49.6 per cent below $1000. The distribution of the children with respect to the cash incomes of their families is shown in Figure 1.

METHODS OF PROCEDURE

Data concerning the socio-economic status of the children's families, as well as their diets were secured by visits to their homes by nurses assisting in the study. The two factors used in this report for representing the socio-economic status of the children were: (a) the cash income of the family; and (b) the education of the adults within the family.

Family Cash Income Groups. For convenience, five arbitrary cash income groups were used in classifying the incomes of the families, as follows:

Class A, $5000 annual cash income and above;
Class B, $4999 to $2500, inclusive;
Class C, $2499 to $1000, inclusive;
Class D, below $1000 but not on direct governmental relief; and
Class E, direct governmental relief.

Family Education Groups. Furthermore, five arbitrary educational groups were used in classifying the respective families of the children as to family education, as follows:

Class A, all adults college graduates with at least a bachelor's degree;

[1]*A joint contribution of The Pennsylvania State College and the Department of Health of the Commonwealth of Pennsylvania. Authorized February 23, 1940, as Paper Number 5 in the Human Nutrition Research Series of the Division of Home Economics Research, The Pennsylvania State College.*
The authors are indebted to Catherine Logan, Anne O'Brien and various technical helpers for valuable assistance in this study.

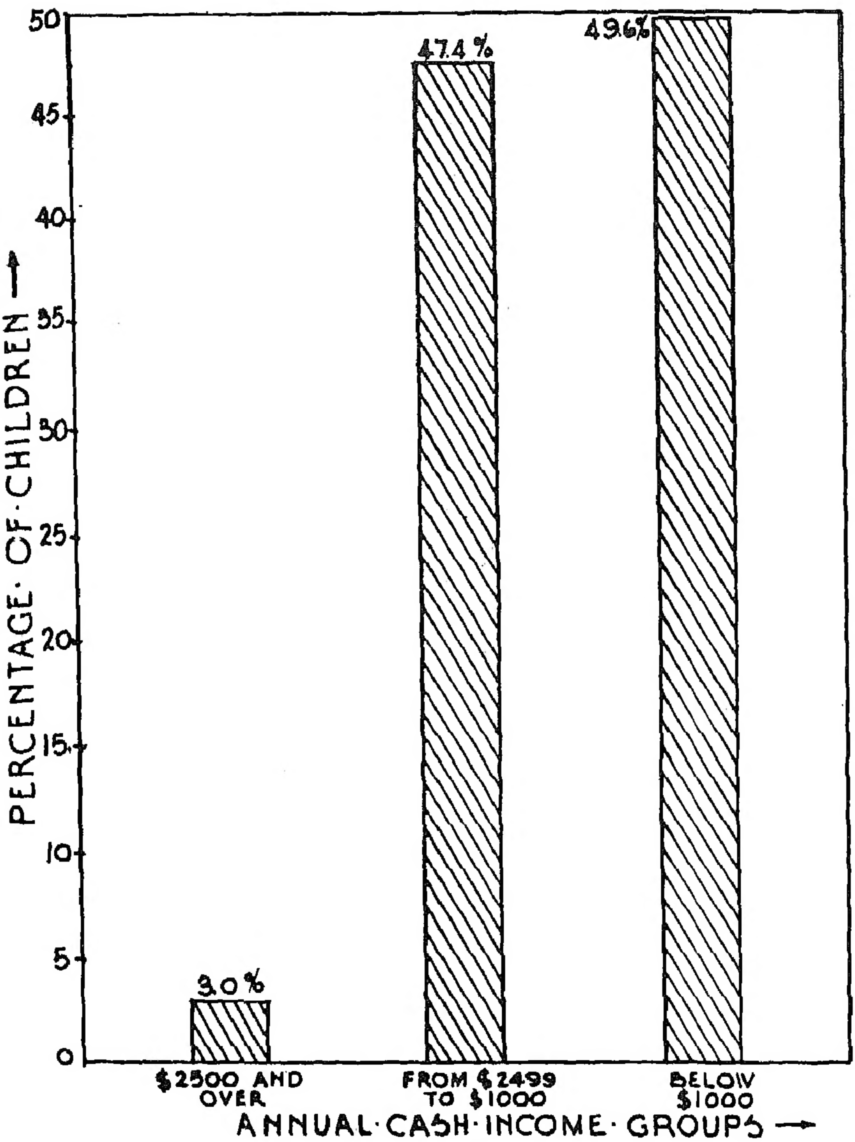

Fig. 1. Percentage Distribution of Children with Respect to Cash Income..

Class B, one adult a college graduate or a recipient of some special training beyond high school;
Class C, all adults high school graduates;
Class D, one or more, but not all adults in the family high school graduates;
Class E, no adult in the family a high school graduate.

Dietary Records. Funds were not sufficient to supervise the keeping of extensive dietary records in this study. A report of the food consumption of each child during a typical three-meal week-day was secured from the mother or other adult in the family by one of the visiting nurses. Independently, each child gave a report of his food intake during a typical three-meal day at two separate times.

Nutritional Measurements. The following nutritional measurements were made on each of the children in the study:

(a) Appearance of nutritional status by a physical examination rating;
(b) Body build and weight status;
(c) Skeletal status - maturation, areas of wrist centers, and degree of mineralization;
(d) Dental status;
(e) Slump, standing and sitting;
(f) Plantar contact;
(g) Hemoglobin status;
(h) Response to a biophotometer test;
(i) Response to a capillary wall strength test.

Details of the nutritional tests have been given by Mack and Smith (5), and consequently only a brief statement is made concerning each test:

A composite score was given to each child as a result of a physical examination in which an adjustable number of points was alloted for such factors as skin, pallor, subcutaneous tissue, musculature, posture, plantar contact, skeletal status, evidence of presence or absence of fatigue, condition of the mouth, luster of the hair, and nervous habits. The highest total score which could be made from this subjective examination was 100 points.

In ascertaining body build, 26 body measurements were taken with calibrated metal anthropometric instruments, from which 16 body build indices were calculated. The results of this part of the study will be reported at a later time. In the present paper, only the weight status of the children is discussed - as ascertained first from the Baldwin-Wood scales (1), and second from the Pryor standards (6).

Skeletal status was ascertained by means of roentgenograms of the left hand (anterior-posterior and lateral aspects), left foot (anterior-posterior and lateral aspects), left elbow (anterior-posterior aspect), and left knee (anterior-posterior aspect). These roentgenograms were used as follows:

(a) A maturation judgment was made on the hand and knee of each subject by comparing them with standards of children of the respective sex as selected by Todd (8) during an extensive study involving children of well-circumstanced families.

The difference between the chronological age of the child in the study and that of the child whose skeletal status seemed equivalent was designated as months of advancement or retardation in skeletal maturity.

(b) The ratio of the area of the ossific centers within the wrist to the wrist area, as determined by a method proposed by Baldwin, Busby, and Garside (2) at Iowa State University was ascertained by the use of a Coradi circumscribing disc planimeter. The ratio of the sum of the wrist ossific center areas to the wrist area, designated as the wrist ossific center index, or the wrist index, is presented as a measure of the growth of the secondary ossification centers in the wrist.

(c) A mineral density factor was obtained by making a tracing of the roentgenogram of the calcaneum between two fixed landmarks by means of a photographic recording photoelectric microphotometer as described by Mack, O'Brien, Smith, and Bauman (4), and by Mack and Smith (5).

A dental score was assigned to each child as a result of a clinical mouth examination, supplemented by roentgenograms, as based on an arbitrary rating scheme involving the degree and extent of caries and the condition of the soft tissues of the mouth.

Two calculations of slump were made for each child by comparing the horizontal with the standing heights and the stem end with the sitting height measurements. The percentage losses in height from changing from a recumbent to a standing position, and from the stem end to the sitting position are called the standing slump and sitting slump, respectively. Some investigators regard slump measurements as denoting muscle tonus, at least in a measure. In the present study, slump values are reported without regard to what they may represent.

The plantar contact values were obtained for each child in the study. The first was calculated as the ratio of the area of the sole of the foot of a subject touching a smooth, flat surface when he was sitting, in comparison with that touching when he was standing, and was reported as the plantar contact sitting / standing ratio. The second was an average of the percentages of the areas of the soles of the two feet touching when the subject was sitting, and was reported as the percentage of plantar contact. Preliminary work in the laboratory of the authors indicates that there may be some association between these two values and present or past nutritional history, but the evidence is not conclusive.

Hemoglobin was measured for each child by the Newcomer method, and reported in terms of grams of hemoglobin to 100 c.c. of blood.

Darkness adaptation was measured by means of a biophotometer. Tests were made with this instrument after 10 minutes in a darkroom; again after a five-minute period looking at the illuminated glass rectangle in the photometer; and after two and one-half, five, seven and one-half, and 10 minutes in subsequent darkness. The tests following bright light exposure were taken between 20 and 25 seconds after the bright light exposure was ended. The subjects were instructed concerning the test and the possible figures which they would see before the test was administered;

they were told to focus their eyes on the center dot of the quincunx when it was visible during the test. The method of calculating the biophotometer data was that described by Mack and Smith (5).

Capillary wall strength was ascertained by the method of Dalldorf (3).

For convenience, responses to each of the various tests have been grouped into five arbitrary classes. In each case, the limits of response to the test for Class 1 were set so as to include subjects believed in the light of present knowledge to be in optimum nutritional condition in the respect covered by the test. Class 5 included cases at the opposite extreme, as indicated by the analysis of the findings on approximately 2000 individuals. The intermediate classes were defined so as to divide the intervening range into convenient intervals. If the response to a certain test was known to be dependent upon sex or age, the definitions of the classes of response to the test were based upon findings for the respective sexes, and for series of chronological ages.

The limits of response to the tests included in the different classes are given in connection with the data which illustrate the distribution of the children with respect to the various tests.

RESULTS OF THE STUDY

The percentage distribution of the children throughout the class groupings for each of the tests is given in Table 1, and is shown graphically in Figures 2 to 13.

Nutritional Status by Physical Examination. The definition of 85 points and over for Class 1 for nutritional status by physical examination concurs with the over-all examination by certain pediatricians accustomed to advise parents on the diet of children, who base their decisions on a subjective estimate of what the appearance of a child in optimum nutritional condition should be. Although no child fell within this class in this unit of the series of studies of which this is a part, some children in other units of the study have received scores which placed them in this class. As is seen in Figure 2, the majority of the children in this study were divided between Class 2 and Class 3 with respect to this physical examination score. Although no child was included in the study who was adjudged by a physician as exhibiting pathological manifestations, 10.8 per cent of the children were scored so low on the various items within the physical examination rating scheme that they fell within Class 4, while only 0.3 per cent were found in the extreme Class 5 group, including those rating 40 points or less.

Weight Status. Although the use of height-weight measurements is common throughout the schools of this country as a means of comparing a child's weight with norms representing the average of children of the same height, weight, and sex, it is doubtful that this measure is valuable for research purposes, because: 1) no objective criterion of normality was available to those preparing such scales; 2) body width is not taken into consideration; and 3) the tables represent average and not optimum body height-weight relations.

The Baldwin-Wood scale is subject to the three objections listed above, and was intended by the investigator introducing it as a method of ascertaining whether a child was growing by measuring him from time

TABLE 1

PERCENTAGE DISTRIBUTION OF CHILDREN WITH RESPECT TO THE VARIOUS NUTRITION TESTS

Nutritional Tests	Class 1	Class 2	Class 3	Class 4	Class 5
Appearance of Nutritional Status by Physical Examination	0.0%	30.8%	58.1%	10.8%	0.3%
Weight Status according to the Baldwin-Wood Standards	67.9	a) 18.9 b) 0.8	a) 7.8 b) 1.0	a) 2.3 b) 0.0	a) 0.5 b) 0.8
Weight Status according to the Pryor Standards	53.4	a) 23.9 b) 1.6	a)12.8 b) 0.5	a) 5.9 b) 0.0	a) 1.6 b) 0.3
Skeletal Status					
Maturity according to Todd Standards	51.2	10.6	12.9	12.2	12.9
Wrist Ossific Center Index	32.7	25.7	23.2	11.3	7.1
Mineral Density Factor	7.4	14.5	18.3	24.4	35.4
Dental Status by Clinical Examination supplemented by Dental X-rays	2.5	22.6	43.9	24.5	6.3
Slump, Standing	91.8	7.2	0.4	0.4	0.0
Sitting	15.7	29.3	42.9	10.1	1.8
Plantar Contact					
Ratio Sitting / Standing Areas	90.5	6.4	2.8	0.0	0.2
Average Sitting Percentages	36.4	37.5	21.2	4.9	0.0
Hemoglobin, in Grams per 100 c.c. blood	1.2	41.2	44.0	13.3	0.2
Biophotometer, Bright Light Factor	9.4	16.9	32.2	35.3	6.1
Darkness Regeneration Factor	20.8	49.2	12.1	8.3	9.5
Total Integration Factor	3.2	36.9	28.9	23.9	6.9
Capillary Wall Strength	37.8	26.8	25.0	8.9	1.4

to time, rather than to ascertain whether he was the proper weight for his height at any given time. Nevertheless, the scales are used extensively throughout the public schools, and the children of this study were compared therewith in order to see how they were distributed on the basis of supposedly normal weight, under-weight, or over-weight in comparison with these averages.

As is seen in Figure 3, Class 1 contained 67.9 per cent of the children in the study; this class consists of children in which the weight was within 10 per cent above or below that shown in the scale for the sex and height of the subject in question. Classes 2(a), 3(a), 4(a) and 5(a), consisting of children within the under-weight limits shown in the table, comprised 18.9, 7.8, 2.3, and 0.5 per cent of the children, respectively. Classes 2(b), 3(b), 4(b) and 5(b), representing over-weight classes as shown in the table, contained but 0.8, 1.0, 0.0, and 0.8 per cent, respectively, of the children in the study. It is evident, therefore, that over-weight was not relatively frequent in occurrence, while 29.5 per cent of the children were under-weight according to this scale. Since this series of standards was based upon a large number of school children, without regard for optimum nutritional status, it is possible

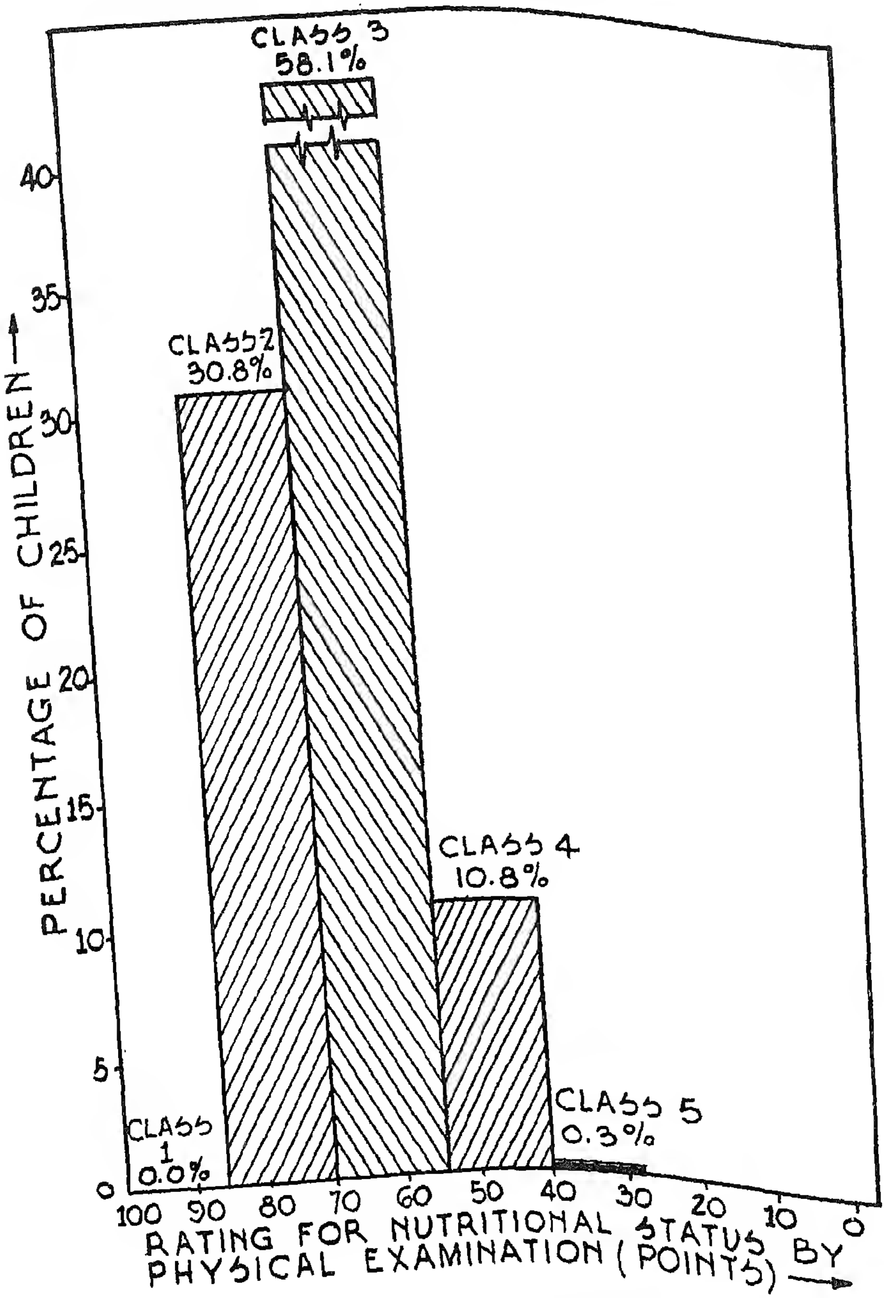

Fig. 2. Percentage Distribution of the Children as to their appearance of Nutritional Status by Physical Examination.

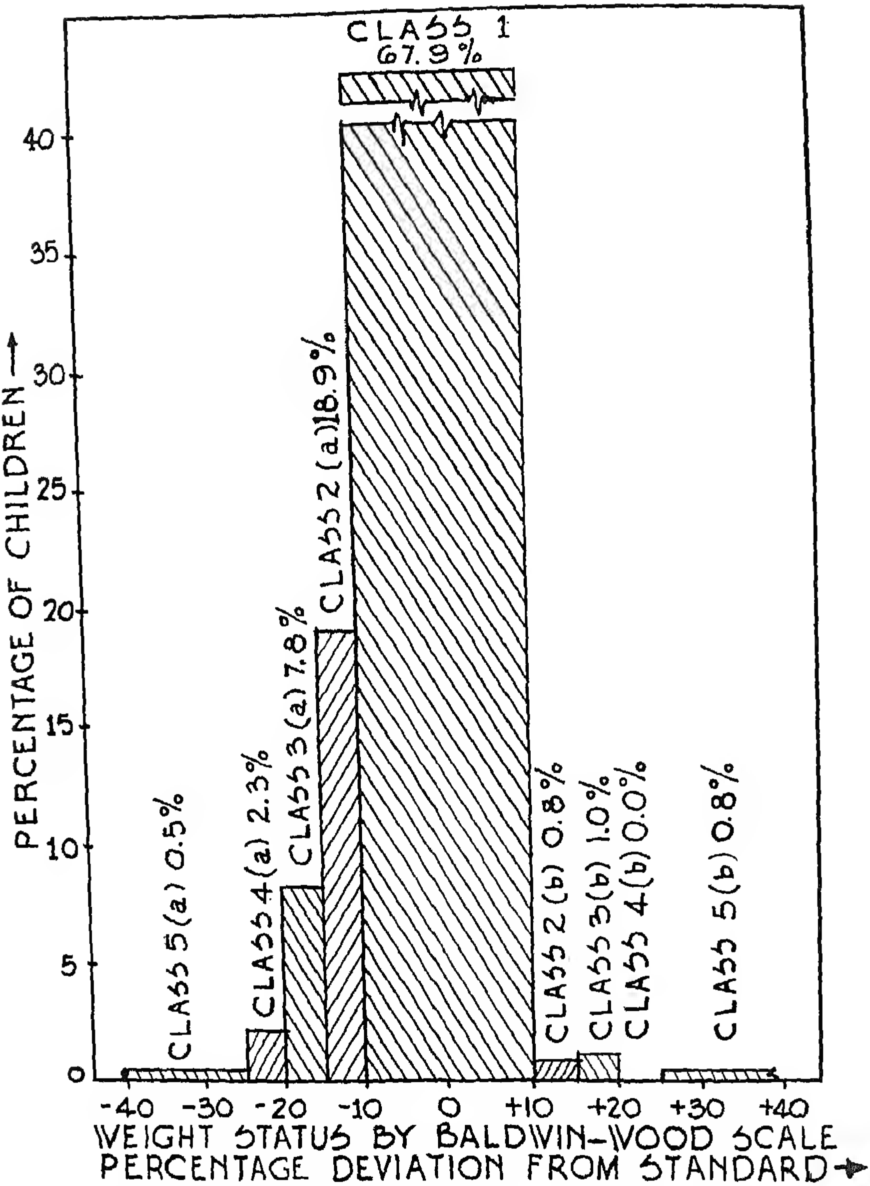

Fig. 3. Percentage Distribution of the Children as to Weight Status as Ascertained by the Baldwin-Wood Scale.

that the percentage of children deviating from an optimum weight for their sex, age, and height was greater than is indicated in this figure.

The Pryor standards, which involve considerations of height, weight, and iliac width of children of the two sexes and of various ages, are not subject to one of the criticisms of the Baldwin-Wood scale, in that a width measurement is included. Figure 4, in which the percentage distribution of the children on the basis of their percentage weight deviation from the standards for their respective sexes, ages, heights, and iliac widths, shows that 53.4 per cent of the children in the study fell within Class 1 according to the Pryor standards. Most of the remainder of the children (44.2 per cent) were in the under-weight classes, which means that they were more than 10 per cent under-weight. Only 2.4 per cent of the children were in the over-weight classes.

Skeletal Status. When the roentgenograms of the children were assayed as to skeletal maturation status by comparing them with Todd standards for hand and knee, it was found that only 51.2 per cent of the children were in Class 1, because they compared satisfactorily with the Todd standards of children of the same sex and age, within six months of the same, chosen by Todd from large numbers of roentgenograms of children with good nutritional histories and from well-to-do families. The remaining children in the study were distributed almost equally among the four lower maturity classes, as is shown in Figure 5.

The wrist-index class distribution is shown in Figure 6. Here it is seen that Class 1 contained 32.7 per cent of the children, with a decreased percentage in each successive class. The arbitrary standards for the classes in this case were set by the authors from a study of the responses (to this test) of a large number of children of various ages and both sexes. As in the other classifications for factors in which age and sex differences pertain, limits were set for age and sex groups for Class 1 so that children which were believed to be optimum in this respect were included. The values for children at the opposite extreme were placed in Class 5, and convenient intervals were established for the intervening classes, for each sex and age classification.

A different story is told by the results of the mineral index classifications, in Figure 7. Whereas the maturity classes as ascertained by comparison with the Todd standards had approximately half of the children in Class 1, and the ratio of the areas of wrist ossific centers to wrist areas were such that about one-third of the children were in the optimum class, only 7.4 per cent of the children were found in Class 1 with respect to skeletal mineralization; the mineralization classes were based upon the findings for about 2000 children, distributed as has been stated, through a wide socio-economic range, whereas the children of this study were chiefly at the middle and lower end of the scale with respect to cash income and family education.

The significance of each of the three skeletal status tests applied in this study has not yet been established. In selecting his maturation standards, and in training others in their use, Todd has stressed the point that evidences of maturity as apart from mere growth or size should serve as the criteria for judging maturation status. He has decried the use of areas, or other measures of ossific center size as indices of maturity, stating that the forlorn hope of judging maturation by this

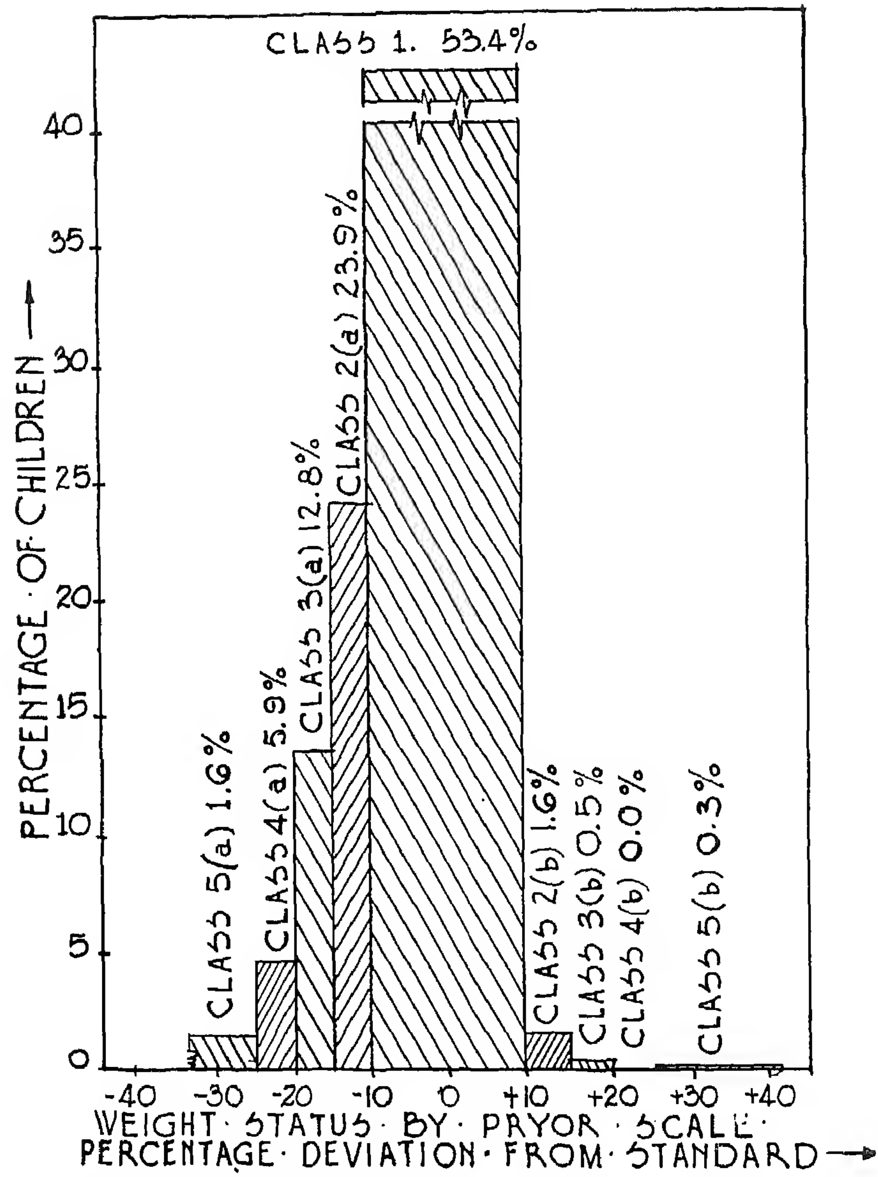

Fig. 4. Percentage Distribution of the Children as to Weight Status as Ascertained by the Pryor Scale.

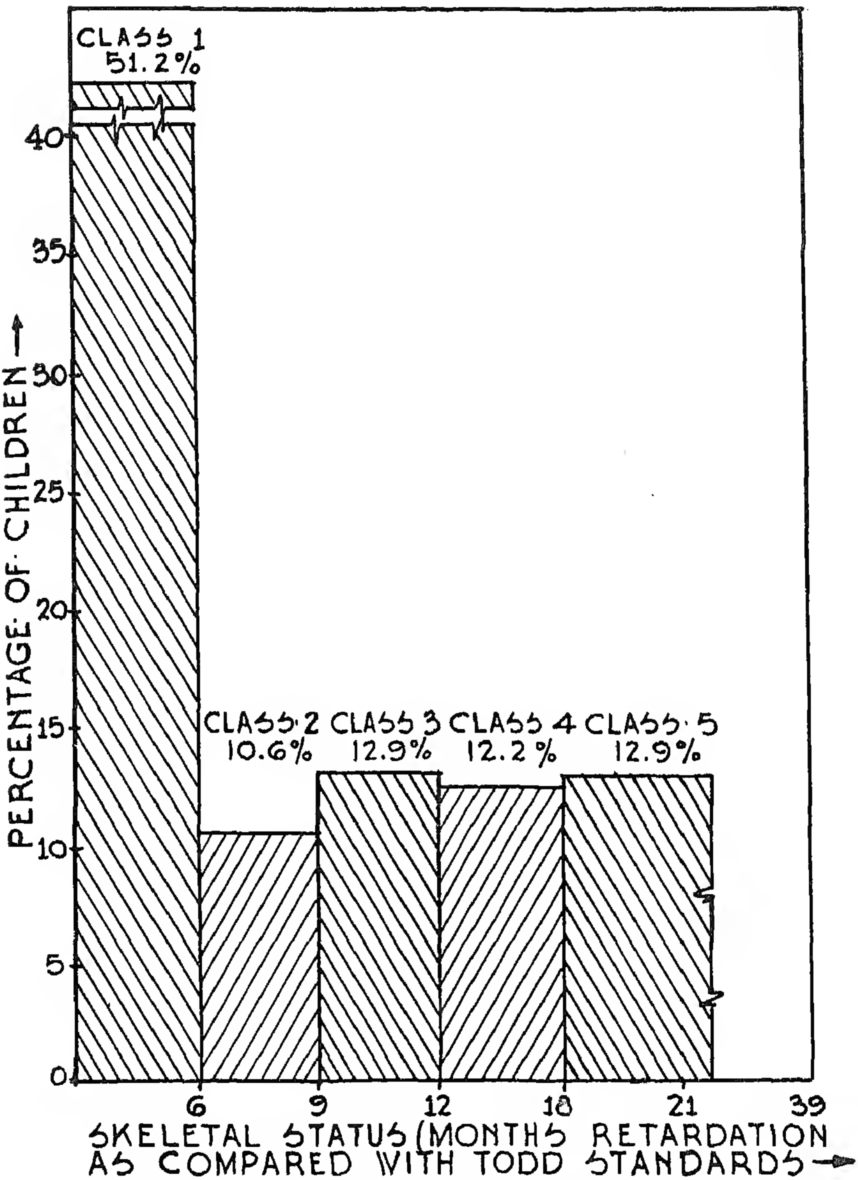

Fig. 5. Distribution of the Children as to Skeletal Maturity as Measured by the Todd Standards. Class 1 represents children who are not retarded more than 6 months as compared with these standards; Class 2 represents children retarded from 6 to 9 months; Class 3 from 9 to 12 months; Class 4 from 12 to 18 months, and Class 5 those retarded more than 18 months.

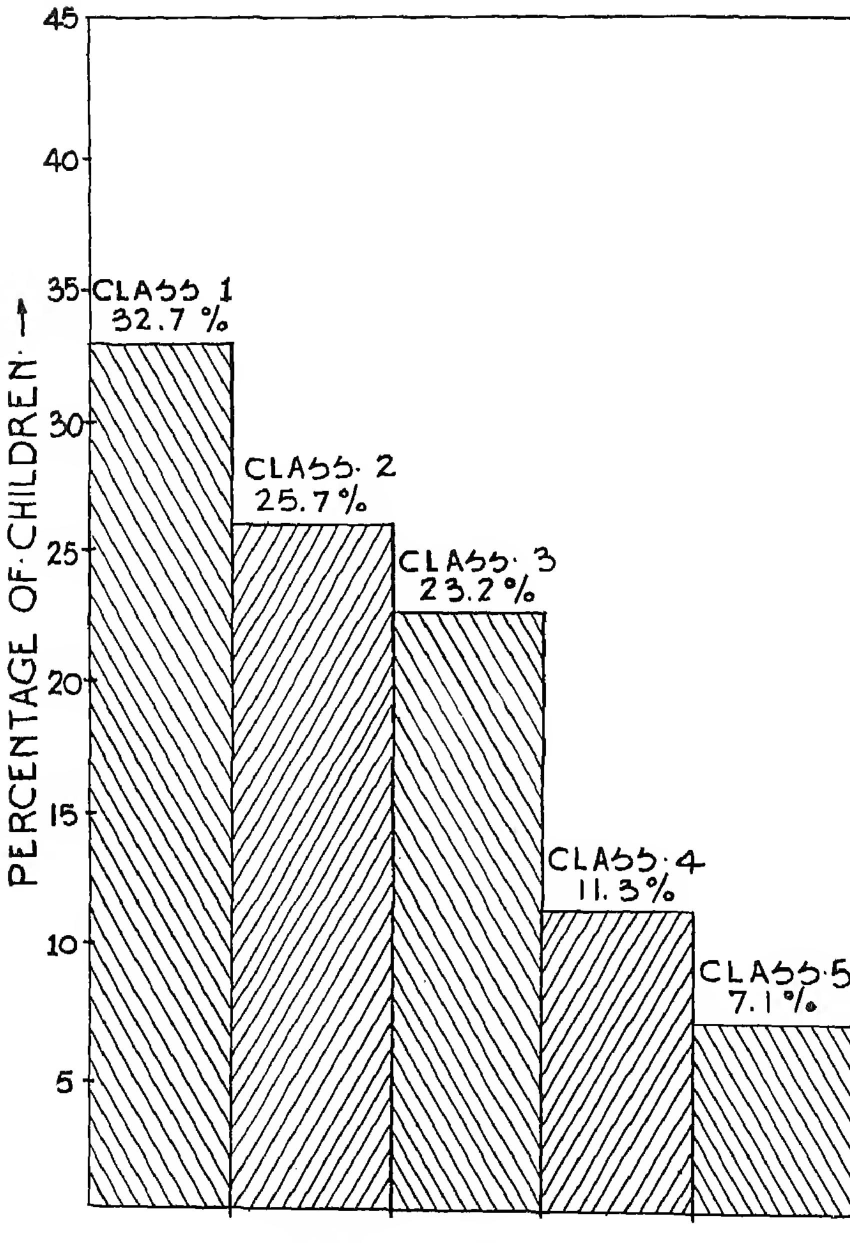

Fig. 6. Distribution of the Children as to Skeletal Status as Ascertained by the Wrist Ossific Center Index.

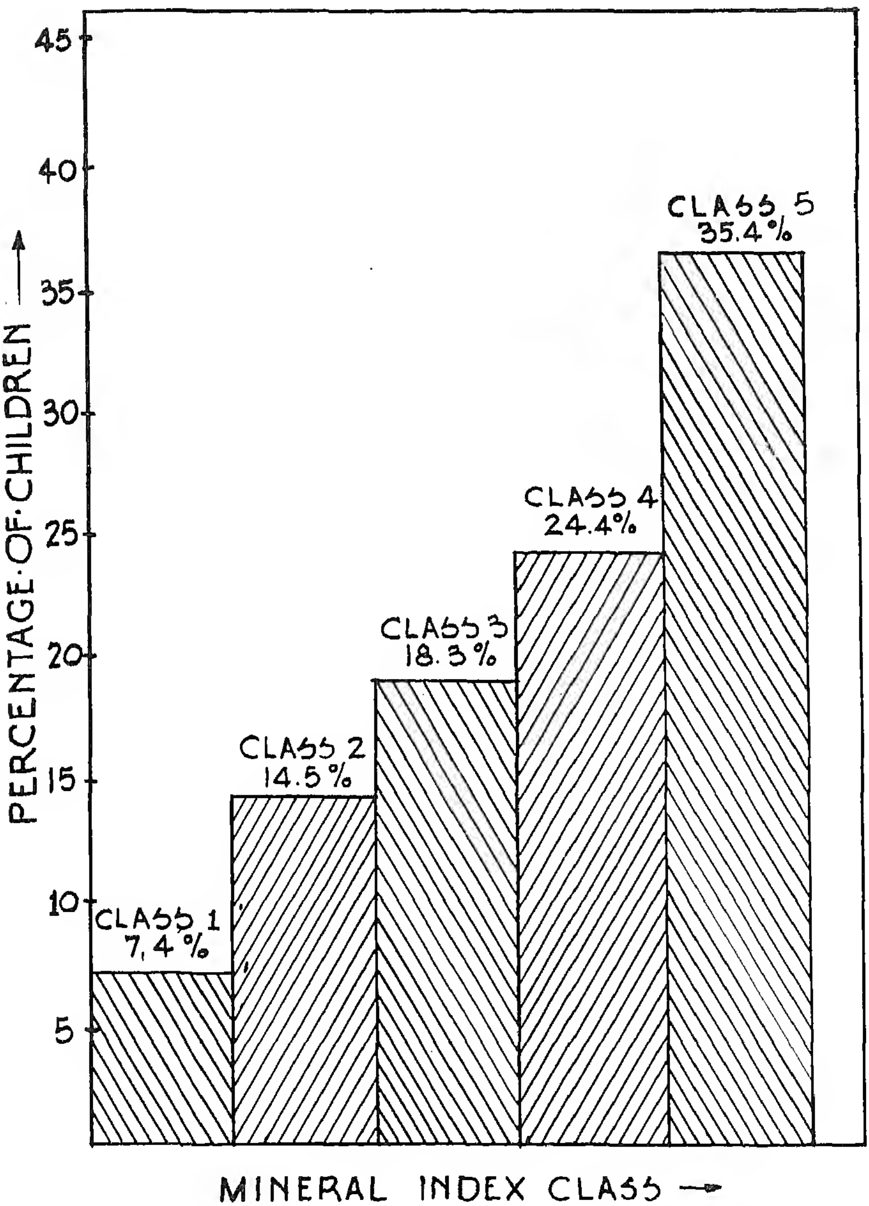

Fig. 7. Distribution of the Children as to Degree of Skeletal Mineralization.

method is based upon the erroneous confusion of maturity with growth. Baldwin, Busby, and Garside (2) on the other hand have used the wrist ossific center index as a measure of physiological growth, a concept which appears to involve not only growth but maturation as well. In using the latter factor (wrist index) in this study, it was not the purpose of the authors to accept it either as a strict measure of maturation or of growth, but rather to find, through this and other studies of this series, with what other nutritional test response factors and nutrient consumption factors it might be related.

In this study, it has been found: 1) that the maturity values as measured by the Todd standards are correlated with the wrist ossific center indices, the coefficient of correlation being $+0.359 \pm 0.03$; 2) that the maturity values as measured by the Todd standards are correlated with the mineral indices, with a coefficient of correlation of $+ 0.2222 \pm 0.03$; and 3) that the wrist ossific center values are correlated with the mineral indices, with a coefficient of correlation of $+ 0.6504 \pm 0.02$. Details of this comparison will be reported in a separate publication.

For the sake of discussion at this point, it may be tentatively assumed that the three processes of skeletal maturation, growth, and mineralization may be simultaneously both related and competing processes, and that they are represented at least partially by the index of maturity according to the Todd standards, the wrist ossific center index, and the mineral index, respectively. It is further assumed by virtue of the method of setting the arbitrary standards that Class 1 represents the optimum for each of the factors, with the other classes representing approximately the same degree of sub-optimum status in each case. On the basis of these assumptions, a scrutiny of the data of this study will show to what extent the classification of each of these three factors is the same as, above, or below the others.

	Percentage of Children
Maturity status (Todd) same class as Wrist Ossific Center Index	30.9%
Maturity status (Todd) above Wrist Ossific Center Index	42.0
Maturity status (Todd) below Wrist Ossific Center Index	27.1
Maturity status (Todd) same as Mineral Index	17.6
Maturity status (Todd) above Mineral Index	68.4
Maturity status (Todd) below Mineral Index	14.0
Wrist Ossific Center Index same as Mineral Index	14.1
Wrist Ossific Center Index above Mineral Index	69.1
Wrist Ossific Center Index below Mineral Index	16.4

From this there is evidently a greater tendency for maturation as measured herein to approach Class 1, or the optimum status, than for the growth of ossific centers, or for the mineralization of bones to do so. Whether or not the ratio of ossific center areas of the wrist to the wrist area is more representative of growth than of maturation, it is

apparently associated both with maturation and mineralization, and is intermediate between the two with respect to the approach to the optimum class of children in a community in which low incomes, and consequent poor diets prevail.

Dental Status. The rating system for dental status was an arbitrary one, based upon the incidence and extent of caries and upon the condition of the soft tissues of the mouth. Class 1 in this rating included children in whom dental caries was absent, as determined by clinical examination supplemented by roentgenograms, and whose mouth tissues were in excellent condition. Figure 8 shows that the children were widely distributed throughout the dental status class range, and that the middle class included a considerably greater percentage than did any of the other classes.

Slump. When the children were classified as to standing slump, 91.8 per cent were found in Class 1, as is seen in Figure 9. When classified as to sitting slump, only 15.7 per cent were found in Class 1, with the greatest number of the cases in Class 3. Since the limits of the various classes were the same both for standing and sitting slump - i.e., the same percentage losses in height (standing or stem end) - were assigned in the two cases, the difference in the distribution is obvious. A greater opportunity for loss in height occurs in the upper part of the body as well as a probably greater tendency to slump when one is sitting than when he is standing. The significance of this test hae not yet been established, although there is an indication that it may be related in extreme cases to certain nutritional conditions.

Plantar Contact. In the series of plantar contact ratings based on the numerical ratio of the area of the sole of the foot touching the supporting surface while the subject was sitting to that touching while he wae standing, 90.5 per cent of the children were found in Class 1, as is seen in Figure 10. In the classifications based upon the percentage of the foot touching while sitting as compared with the area of the entire sole, however, only 36.4 per cent were found in Class 1, with 37.5 per cent in Class 2, and the remainder in the three lower classes.

Hemoglobin Status. Only 1.2 per cent of the children were in Class 1 with reepect to hemoglobin status, as is seen in Figure 11, with 13 grams of hemoglobin per 100 c.c. of blood, or more. In Class 2, with hemoglobin values ranging between 12.9 and 11.5 grams per 100 c.c. of blood, 41.2 per cent of the children were found; 44.0 per cent were in Class 3 having values between 11.4 and 10.0 grams per 100 c.c.; 13.3 per cent were in Class 4 with values between 9.9 and 7.5 grams per 100 c.c.; and none of the children of this study were in Class 5, with values below 7.5 grams per 100 c.c.

Darkness Adaptation Status. According to the bright light factor as obtained by the use of the biophotometer, Figure 12, only 9.4 per cent of the children were in Class 1, while 41.4 per cent were in the two lowest classes. A subsequent study with these same children was made, to be reported later, in which vitamin A concentrates were administered for a period of time to some of the children in each of the initial classes. The average biophotometer bright light factors, as well as the various other biophotometer factors, of all of the groups of children save those in the highest classes were raised by this administration - a

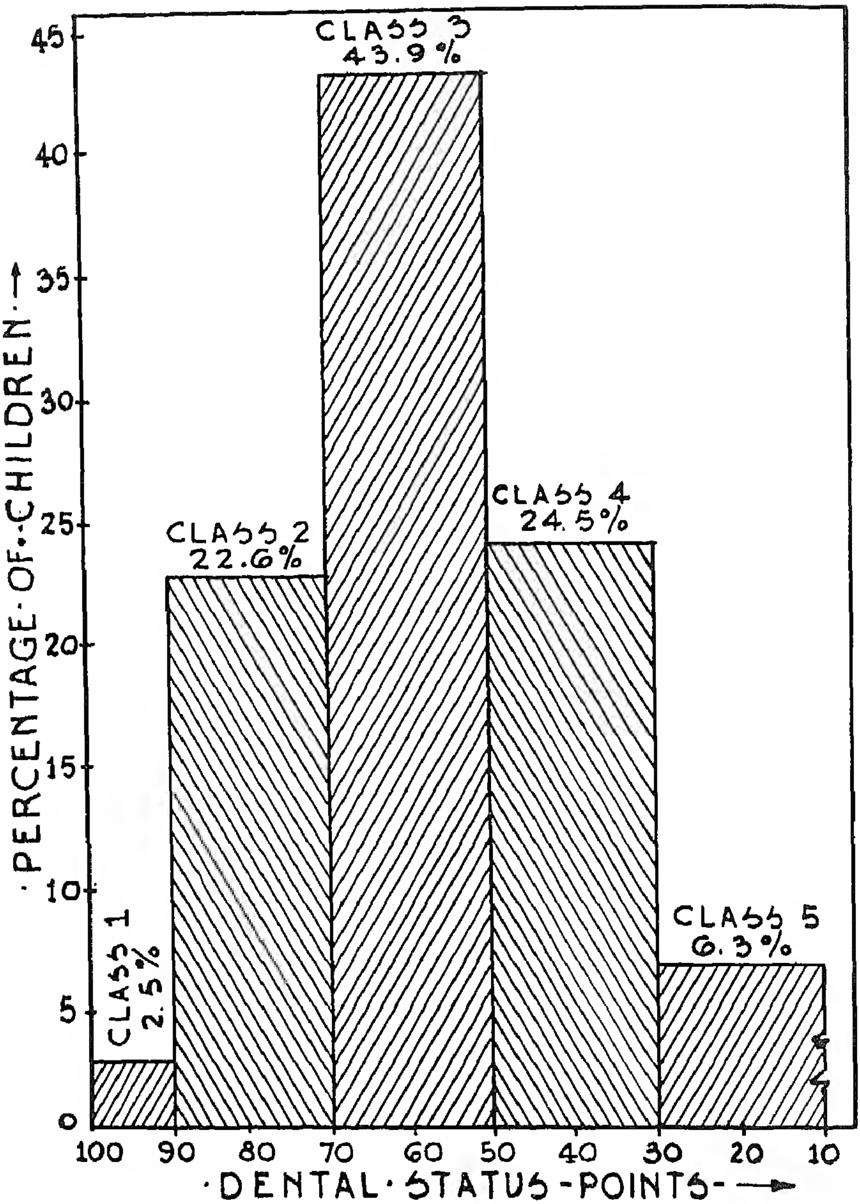

Fig. 8. Distribution of Children as to Dental Rating.

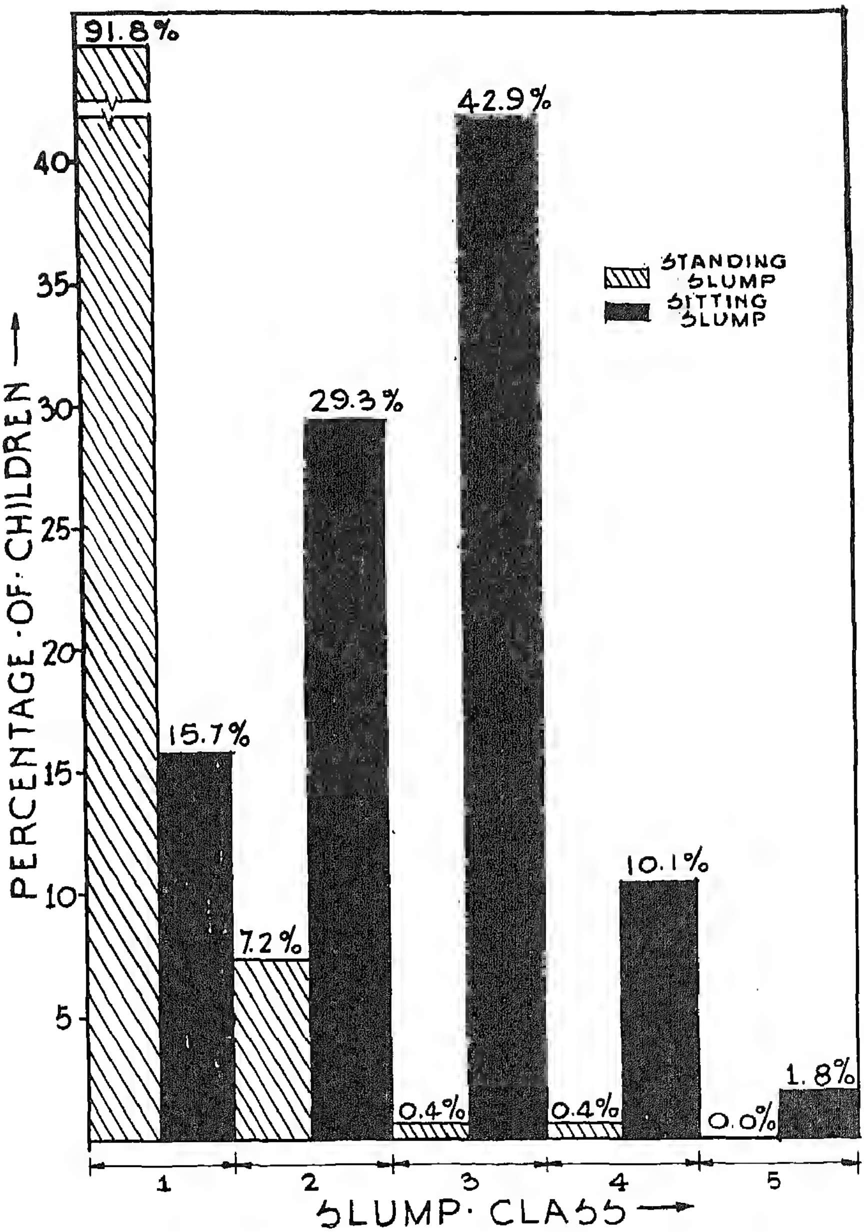

Fig. 9. Distribution of Children as to Standing and Sitting Slump.

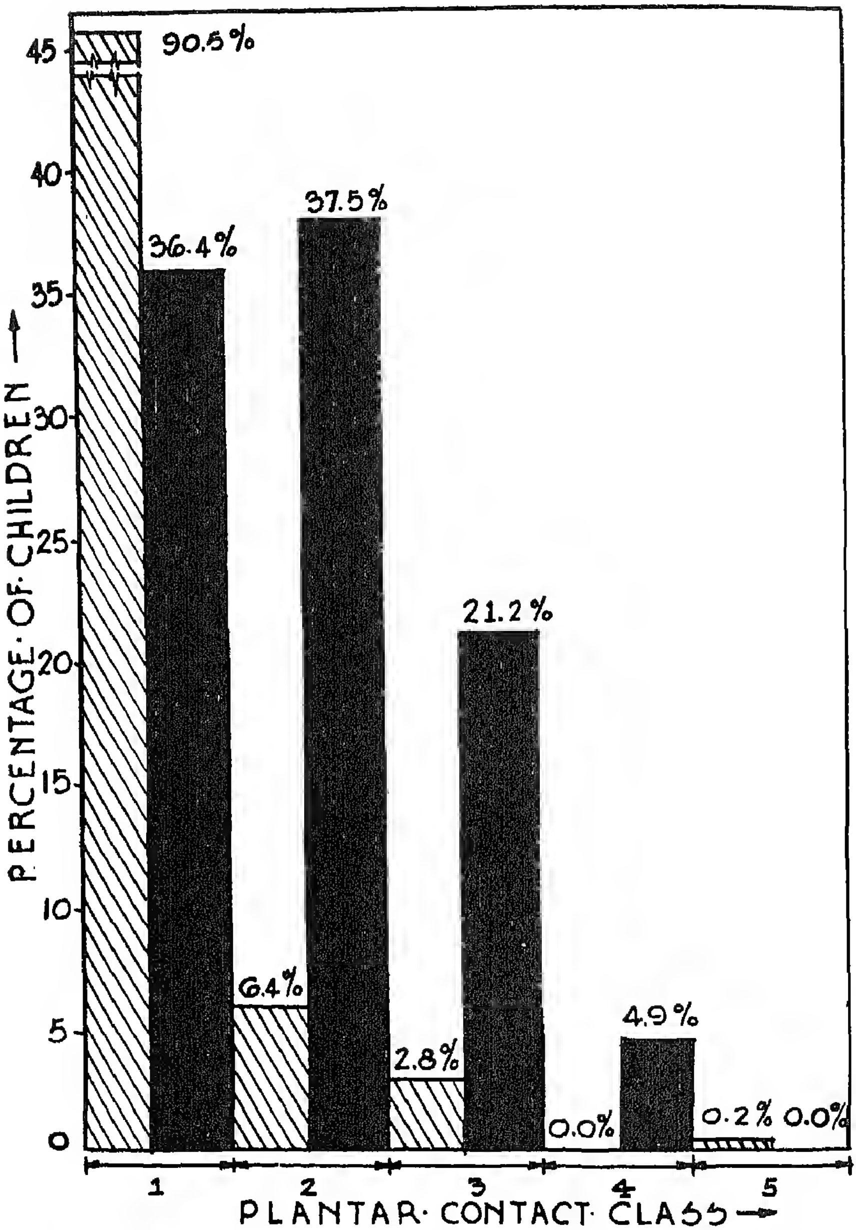

Fig. 10. Distribution of Children as to Plantar Contact Status:
(1) as indicated by the ratio of contact while sitting to that of standing;
(2) as indicated by the percentage of plantar contact while sitting.

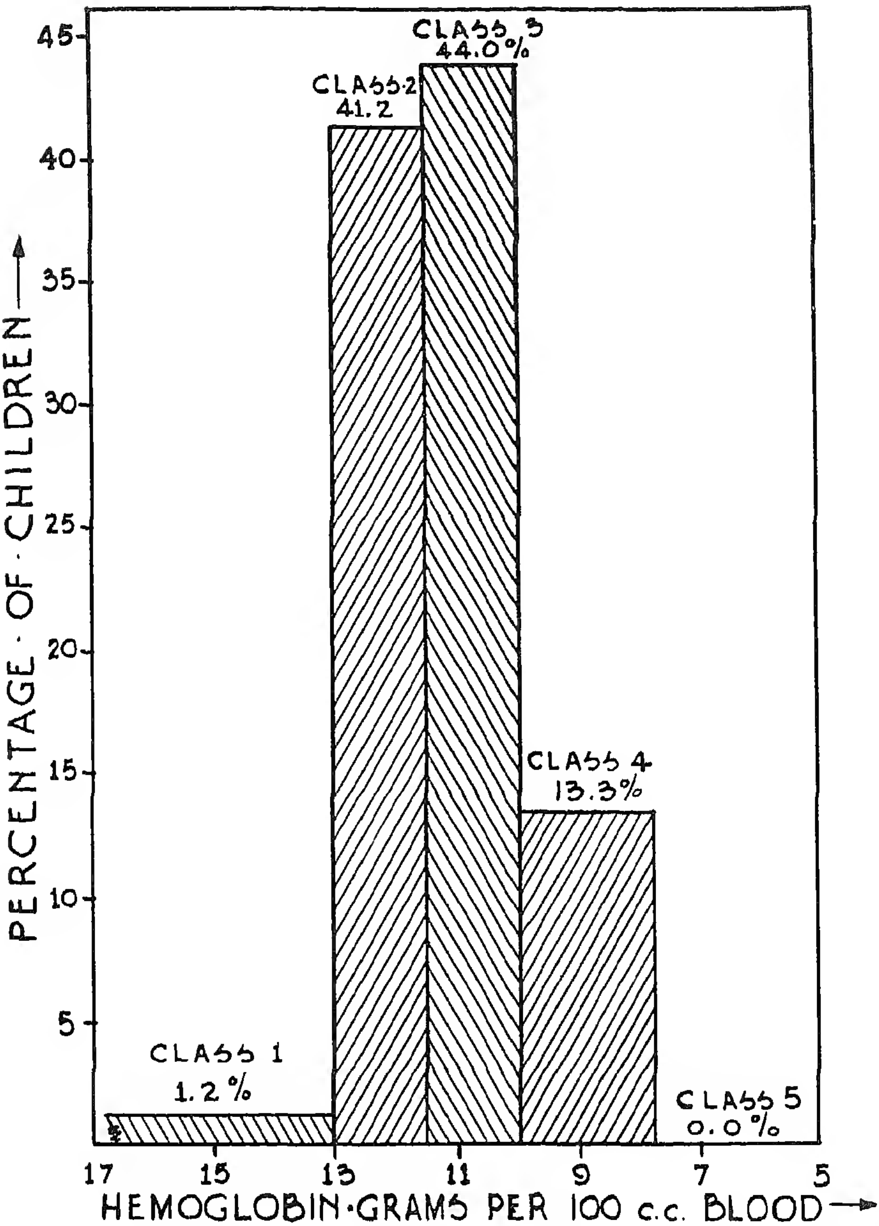

Fig. 11. Percentage Distribution of Children as to Hemoglobin Status.

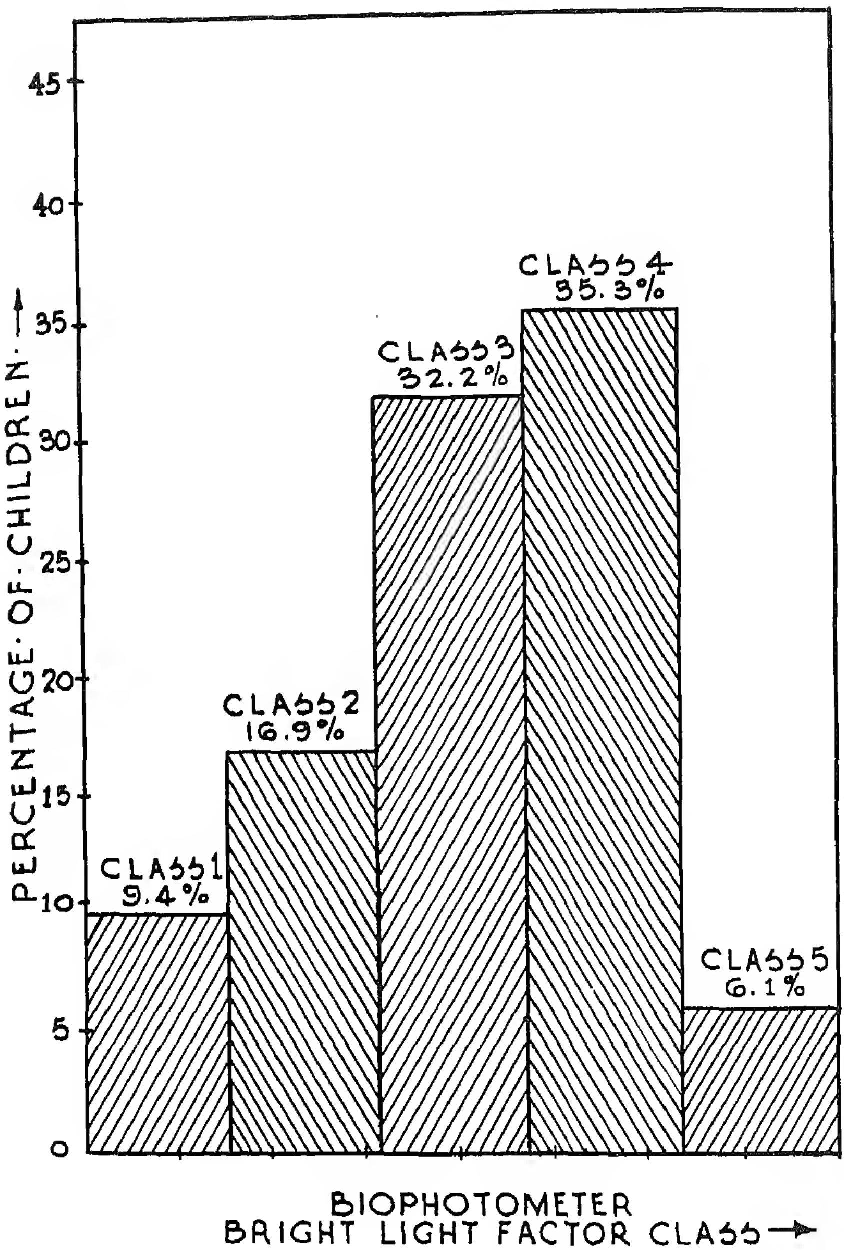

Fig. 12. Percentage Distribution of Children as to the Biophotometer Bright Light Factor. Class 1 includes those having a bright light factor of 0 - 0.30 millifoot candles; Class 2 of 0.61 to 1.09; Class 4 of 1.10 to 3.59; and Class 5 of 3.60 millifoot candles and above.

fact which attests further to the low status of these children with respect to darkness adaptation.

In Table 1, the distributions of the children on the basis of two biophotometer factors other than the bright light factor have been given. A higher percentage of the children were in Class 1 on the basis of the darkness regeneration factor, which is obtained at the end of the final darkness period, than was the case with the bright light factor. Even so, the proportion of children in this class was not large, being only 20.8 per cent. On the basis of the total integration factor, a value representing the area under the curve for the entire series of biophotometer tests, a strikingly small number of children were in the better classes.

Capillary Wall Strength. The possible significance of the capillary wall strength test has been discussed by Sybil Smith (7). Probably this test indicates severe degrees of vitamin C under-nutrition, as well as general nutritional status. Besides the implications of the results of this test, Figure 13 shows that 37.8 per cent of the children in this study were classed in the highest group, with progressively smaller percentages found in the succeeding groups. In some groups of privileged children in the larger study of which this is a unit, 100 per cent of the children have been found in Class 1 with respect to response to this test.

Socio-Economic Status and Response to Nutrition Tests - Income of Family. The cash incomes of the families of the children did not appear to be related to their average ratings in the following cases:

Weight Status Classes (There was no association of income class with deviation from the standard for both under-weight and over-weight combined. A tendency was shown, however, for a greater degree of under-weight in the families with lower incomes.);

Dental Status Classes;

Slump Classes; and

Capillary Wall Strength.

The family cash incomes were apparently related, on the other hand, to the responses to the following tests:

Appearance of Nutritional Status by Physical Examination - the average points were higher for Income Classes A and B combined than for Class C, and Classes D and E combined. There were no significant differences, however, between the averages of Class C and of Classes D and E combined.

Skeletal Status - The average classes for all three skeletal status factors for children within the different income groups became progressively poorer as the income classes became lower.

Hemoglobin Status - The average grams of hemoglobin per 100 c.c. of blood was 12.04 for Income Classes A and B combined, 11.51 for Income Class C, and 11.04 for Income Classes D and E, combined. A highly significant difference was shown between

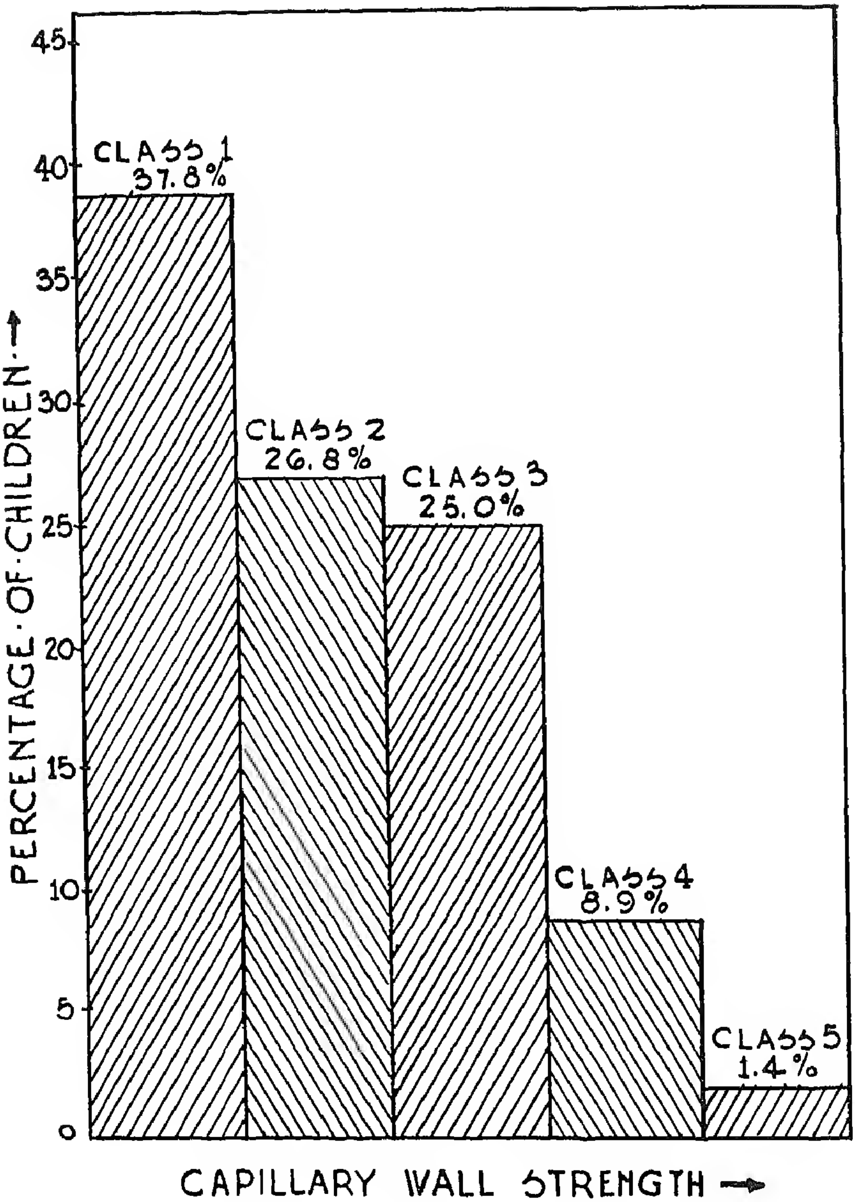

Fig. 13. Percentage Distribution of Children as to the Capillary Wall Strength.

Income Classes A and B combined, when compared with D and E combined, with odds greater than 100:1 that the difference did not occur by chance. Slightly significant differences (Odds 20:1) were established between the combined A and B classes and the C class, and between the C class and the combined D and E Income classes.

Darkness Adaptation Status - A tendency toward a lower average biophotometer rating with a lower income was shown for all of the biophotometer factors used. The greatest difference, however, was established between the darkness regeneration factor, or the response to the test at the end of the 10-minute darkness regeneration period.

Education of Family Adults. Although the children were chosen on the basis of their family income, and not of their family education, a highly significant correlation was established between the cash incomes of the families of the children and the degree of formal education of the adult family members. The following was the percentage distribution of the families on the basis of the arbitrary education classes previously defined:

Education Class A	0.5%
Education Class B	7.5
Education Class C	2.6
Education Class D	7.9
Education Class E	81.3

The average responses to the tests when the children were classified on the basis of the family educational rating showed the same tendencies as those shown when they were grouped according to cash incomes.

Children's Dietaries. An analysis of the dietaries of the children in this study will be given in greater detail in a later publication. A summary of the weekly intake of the chief dietary items by income classes follows in Table 2.

From the data in Table 2, it is seen that a sharp drop with a decreasing income was shown in the consumption of the items of diet most likely to be associated with the so-called protective foods. Thus, milk and meat were consumed in less than half the per capita quantity by children in the two lower income groups combined than by those in the two upper groups, with egg consumption falling to about 65 per cent that of the higher income groups. The consumption of citrus fruits by the two lowest income groups combined was less than one-third that by the two highest groups. Other fruits did not show this drop. The consumption of green vegetables and of yellow vegetables fell sharply and tomatoes slightly with decreasing incomes, while bread and potatoes were consumed in somewhat larger quantity by children in the lower income groups.

This finding, coupled with the fact that responses to certain of the nutritional tests related to the consumption of the protective foods were poorer in the lower income groups points to the desirability of making a free or low-priced school lunch available to children in these income brackets. It shows further the lack of wisdom in following the

TABLE 2

WEEKLY AVERAGE DIETARY INTAKE OF CHILDREN
BY INCOME CLASSES

Summary of Food Intake per Week	Income Classes		
	A and B Combined	C	D and E Combined
Milk, quarts	4.6	3.3	2.2
Meat, servings	4.8	3.7	2.9
Eggs, besides in cooking	2.8	2.3	1.8
Citrus fruit, servings	3.8	2.8	1.2
Other fruit	4.9	5.5	4.3
Vegetables, Potatoes	4.5	5.0	5.6
Green	5.7	3.8	2.7
Yellow	2.4	1.1	1.6
Tomatoes	2.6	2.0	2.1
Bread, slices per day	6.6	7.0	7.0

tendency of making such a lunch high in energy without especial regard for the protein, mineral, or vitamin content thereof, since the home diets of the low income children in the study (none of them ate at a school lunch) indicate the soundness of the reverse policy.

SUMMARY

A study was made of the dietary habits and nutritional status of 428 representative children in an industrial city of about 82,000 inhabitants, where low incomes prevailed. Nine tests for nutritional status were applied, and the percentage distribution of the children with respect to these tests was presented graphically. The relationship of the responses to the tests and the socio-economic status of the child's family as measured by cash income and education of adult members was discussed, as well as the significance of the consumption of the main items of food by children in the different income groups.

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FACTORS IN THE GROWTH OF GIRLS[1]

FRANCES A. MULLEN[2]

The intercorrelations of seventeen physical measurements of girls of various age groups have been analyzed to determine: 1) the portion of the variance at each age which may be ascribed to a general growth factor; 2) the group and special factors which may be necessary to account for the residual correlations at each age; 3) whether one estimate of the general and group factors may be used at all ages, in the study of the growth of the factors, and 4) the relationship of such factors, both general and group, to the age at which puberty occurs.

The intercorrelations have been analyzed by the bi-factor technique developed by Holzinger (4). This method of factor analysis assumes a general factor to account for the positive character of the correlational matrix, and independent group factors to account for higher correlations within a restricted group of measurements than would be produced by the general factor alone. To the general factor is ascribed as much of the variance of each individual measure as is consonant with the magnitude of the correlation coefficients and with the postulated group factors. The residual correlations are then accounted for by group factors which are the general factors common to a restricted group of residuals, and by special factors for each measurement.

The analysis presented in this paper will show that it is possible to obtain an excellent fit to the present correlation tables by such an assumption of general, group, and special factors, all independent of each other. It would have been possible, however, to have postulated group factors without a general factor, even though the correlations are all positive. In such a case the group factors must either overlap, as they do in most multiple factor analyses, where each factor has loadings in practically all of the measurements, or the group factors must themselves be correlated, not independent. The choice between these methods of factoring the observed correlations must be made not on mathematical grounds but in view of such questions as: Which method gives the most understandable and parsimonious description of the factors? Which analysis gives results of most use to the geneticist or student of child development in his effort to understand the underlying phenomena?

The subjects of the study are girls enrolled in the Laboratory Schools of the University of Chicago. The measurements, made by physicians on the staff of the schools during the years 1927-37, are as follows: height, arm span, length of right forearm, length of right lower leg, sitting height, weight, bi-iliac diameter, bi-trochanteric diameter, chest girth, chest width, chest depth, shoulder width, head length, head width, head height, lung capacity, and right hand squeeze. The technique used in making and recording each measurement is described by Bolmeier (1). The measurements were made as nearly as possible on the date of the child's birthday. For the records used in this study the average date of

[1]*The writer wishes to acknowledge her indebtedness to Dr. Karl J. Holzinger, under whose direction this study was carried out, and to Dr. Frank N. Freeman, who made available the records of the Laboratory Schools of the University of Chicago.*

[2]*From the Bureau of Child Study, Board of Education, Chicago.*

examination was 2.005 days after the birthday, with a mean deviation of 6.24 days. Since each age group is treated separately, age is well controlled and need not be allowed for statistically.

The study is limited to girls of the ages of seven, nine, eleven, thirteen, fifteen, and seventeen. All records in the files for girls of these ages were used in this study if they were complete in the seventeen selected measurements, with the exception of seven records discarded because of inconsistencies.

The 136 possible intercorrelations of the seventeen measurements at each age level were computed by the product-moment technique. In analyzing the resulting correlational matrices, two clusters of variables became evident. The five variables: height, arm span, length of right forearm, length of right lower leg, and sitting height have at all ages higher intra-group than extra-group correlations. Similarly, the seven variables: weight, the two hip measures, the three chest measures, and shoulder width, form a second cluster. The identification of these clusters was made by the use of the B-coefficient (4, p. 23) and verified by the goodness of fit of the resulting factor patterns. Sitting height, however, proved on further study to be related to the first group largely through its high correlation with standing height and to have insignificant factor loadings with the first group factor. Similarly shoulder width is the most doubtful member of the second group. No grouping could be set up among the remaining five variables.

At most age levels, four correlations appeared to be significantly higher than could be accounted for by the general and group factors here postulated. In the final calculations of the factor loadings, the results of which are shown in Tables 1 to 6, allowance was made for these overlaps.

The entries in these tables may be interpreted in several ways. Each factor loading is the correlation of the given variable with the hypothetical factor. Each loading is also the square root of the proportion of the total variance of a given measure which may be ascribed to that factor. Finally, the correlation between any two variables should be reproduced by the sum of the products of the factor loadings which the two variables have in common.

The various measures correlate much more highly with the general factor than they do with the two group factors. For the last five measures, however, and for some of the second group of measures, a large part of the variance cannot be ascribed to general or group factors, or to doublets, but must be accounted for by factors unique to each measure.

To check the accuracy with which the factor patterns fit the observed correlations, the differences between the theoretical correlations (computed from the sum of the products of the loadings of such factors as the two variables have in common) and the observed correlations have been computed. It should not be expected that these residuals will all be exactly zero, but they should distribute around zero. The means and variabilities of the residuals for each age are shown in Table 7. It will be noted that .6745 times the standard deviation of each of these distributions is less than the probable error of a zero correlation for a population of the size of each of these age groups.

The probable error of a zero correlation has been suggested as a

TABLE 1

FACTOR LOADINGS FROM THE CORRELATIONS BETWEEN SEVENTEEN PHYSICAL MEASUREMENTS OF 189 SEVEN-YEAR-OLD GIRLS

Variables	α	β	γ	D_1	D_2	D_3	D_4	ω_i
Height	.878	.372	-	-	-	-	.000	.301
Arm span	.797	.488	-	.000	-	-	-	.356
Forearm	.756	.568	-	-	-	-	-	.326
Lower leg	.823	.440	-	-	-	-	-	.359
Sitting height	.832	.000	-	-	-	-	.000	.555
Weight	.834	-	.445	-	-	-	-	.326
Bi-iliac diameter	.677	-	.451	-	-	-	-	.581
Bi-trochanteric "	.744	-	.488	-	-	-	-	.456
Chest girth	.682	-	.466	-	-	-	-	.564
Chest width	.590	-	.432	-	-	-	-	.682
Chest depth	.527	-	.336	-	-	-	-	.780
Shoulder width	.703	-	.200 a	.000	-	-	-	.682
Head length	.398	-	-	-	.444	-	-	.803
Head width	.352	-	-	-	-	.270	-	.896
Head height	.323	-	-	-	.444	.270	-	.791
Hand squeeze	.299	-	-	-	-	-	-	.954
Lung capacity	.397	-	-	-	-	-	-	.918
Total variance	7.273	.893	1.196	.000	.394	.146	.000	7.096
Per cent variance	42.8	5.4	7.0	.0	2.3	.9	.0	41.7

a Insignificant.

TABLE 2

FACTOR LOADINGS FROM THE CORRELATIONS BETWEEN SEVENTEEN PHYSICAL MEASUREMENTS OF 212 NINE-YEAR-OLD GIRLS

Variables	α	β	γ	D_1	D_2	D_3	D_4	ω_i
Height	.840	.424	-	-	-	-	.210	.266
Arm span	.792	.510	-	.179	-	-	-	.284
Length of forearm	.796	.543	-	-	-	-	-	.268
Length of lower leg	.868	.318	-	-	-	-	-	.382
Sitting height	.773	.049 a	-	-	-	-	.210	.597
Weight	.768	-	.542	-	-	-	-	.241
Bi-iliac diameter	.668	-	.487	-	-	-	-	.563
Bi-trochanteric "	.611	-	.642	-	-	-	-	.464
Chest girth	.582	-	.598	-	-	-	-	.551
Chest width	.544	-	.521	-	-	-	-	..658
Chest depth	.465	-	.565	-	-	-	-	.682
Shoulder width	.626	-	.346	.179	-	-	-	.676
Head length	.482	-	-	-	.438	-	-	.759
Head width	.248	-	-	-	-	.300	-	.921
Head height	.291	-	-	-	.438	.300	-	.796
Hand squeeze	.544	-	-	-	-	-	-	.839
Lung capacity	.514	-	-	-	-	-	-	.858
Total variance	6.908	.838	2.011	.064	.384	.180	.088	6.531
Per cent variance	40.6	4.9	11.8	.4	2.3	1.1	.5	38.4

a Insignificant.

TABLE 3

FACTOR LOADINGS FROM THE CORRELATIONS BETWEEN SEVENTEEN PHYSICAL MEASUREMENTS OF 230 ELEVEN-YEAR-OLD GIRLS

Variables	α	β	γ	D_1	D_2	D_3	D_4	ω_i
Height	.888	.344	-	-	-	-	.207	.224
Arm span	.863	.403	-	.017	-	-	-	.304
Length of forearm	.857	.472	-	-	-	-	-	.207
Length of lower leg	.871	.338	-	-	-	-	-	.356
Sitting height	.833	.000	-	-	-	-	.207	.513
Weight	.784	-	.536	-	-	-	-	.313
Bi-iliac diameter	.735	-	.495	-	-	-	-	.464
Bi-trochanteric "	.750	-	.529	-	-	-	-	.397
Chest girth	.755	-	.467	-	-	-	-	.460
Chest width	.628	-	.595	-	-	-	-	.502
Chest depth	.551	-	.499	-	-	-	-	.669
Shoulder width	.680	-	.255	.017	-	-	-	.687
Head length	.401	-	-	-	.381	-	-	.833
Head width	.237	-	-	-	-	.363	-	.901
Head height	.378	-	-	-	.381	.363	-	.762
Hand squeeze	.599	-	-	-	-	-	-	.801
Lung capacity	.577	-	-	-	-	-	-	.817
Total variance	8.220	.618	1.698	.006	.290	.264	.086	5.825
Per cent variance	48.4	3.6	10.0	.0	1.7	1.5	.5	34.3

TABLE 4

FACTOR LOADINGS FROM THE CORRELATIONS BETWEEN SEVENTEEN PHYSICAL MEASUREMENTS OF 219 THIRTEEN-YEAR-OLD GIRLS

Variables	α	β	γ	D_1	D_2	D_3	D_4	ω_i
Height	.769	.552	-	-	-	-	.276	.167
Arm span	.712	.611	-	.000	-	-	-	.348
Length of forearm	.661	.711	-	-	-	-	-	.241
Length of lower leg	.675	.541	-	-	-	-	-	.502
Sitting height	.742	.136 [a]	-	-	-	-	.276	.596
Weight	.752	-	.580	-	-	-	-	.313
Bi-iliac diameter	.661	-	.355	-	-	-	-	.661
Bi-trochanteric "	.738	-	.416	-	-	-	-	.531
Chest girth	.500	-	.625	-	-	-	-	.599
Chest width	.603	-	.523	-	-	-	-	.602
Chest depth	.429	-	.401	-	-	-	-	.809
Shoulder width	.699	-	.196 [a]	-	-	-	-	.688
Head length	.439	-	-	-	.000	-	-	.898
Head width	.286	-	-	-	-	.497	-	.819
Head height	.470	-	-	-	.000	.497	-	.729
Hand squeeze	.544	-	-	-	-	-	-	.839
Lung capacity	.629	-	-	-	-	-	-	.777
Total variance	6.554	1.495	1.499	.000	.000	.494	.152	6.798
Per cent variance	38.6	8.8	8.8	.0	.0	2.9	.9	40.0

[a] Insignificant.

TABLE 5

FACTOR LOADINGS FROM THE CORRELATIONS BETWEEN SEVENTEEN PHYSICAL MEASUREMENTS OF 305 FIFTEEN-YEAR-OLD GIRLS

Variables	α	β	γ	D_1	D_2	D_3	D_4	ω_i
Height	.691	.614	-	-	-	-	.354	.142
Arm span	.591	.740	-	.251	-	-	-	.200
Length of forearm	.581	.704	-	-	-	-	-	.409
Length of lower leg	.598	.652	-	-	-	-	-	.466
Sitting height	.674	.116 [a]	-	-	-	-	.354	.638
Weight	.694	-	.623	-	-	-	-	.361
Bi-iliac diameter	.551	-	.339	-	-	-	-	.762
Bi-trochanteric "	.611	-	.560	-	-	-	-	.559
Chest girth	.562	-	.453	-	-	-	-	.692
Chest width	.596	-	.473	-	-	-	-	.649
Chest depth	.407	-	.362	-	-	-	-	.838
Shoulder width	.579	-	.089 [a]	.500	-	-	-	.638
Head length	.330	-	-	-	.327	-	-	.886
Head width	.383	-	-	-	-	.292	-	.876
Head height	.297	-	-	-	.327	.292	-	.848
Hand squeeze	.496	-	-	-	-	-	-	.868
Lung capacity	.695	-	-	-	-	-	-	.719
Total variance	5.380	1.859	1.385	.313	.214	.171	.251	7.427
Per cent variance	31.6	10.9	8.1	1.8	1.3	1.0	1.5	43.7

[a] Insignificant.

TABLE 6

FACTOR LOADINGS FROM THE CORRELATIONS BETWEEN SEVENTEEN PHYSICAL MEASUREMENTS OF 165 SEVENTEEN-YEAR-OLD GIRLS

Variables	α	β	γ	D_1	D_2	D_3	D_4	ω_i
Height	.620	.624	-	-	-	-	.365	.305
Arm span	.546	.756	-	.276	-	-	-	.233
Length of forearm	.501	.783	-	-	-	-	-	.369
Length of lower leg	.572	.713	-	-	-	-	-	.405
Sitting height	.562	.142 [a]	-	-	-	-	.365	.729
Weight	.764	-	.531	-	-	-	-	.366
Bi-iliac diameter	.466	-	.405	-	-	-	-	.787
Bi-trochanteric "	.606	-	.500	-	-	-	-	.619
Chest girth	.609	-	.283	-	-	-	-	.741
Chest width	.670	-	.446	-	-	-	-	.593
Chest depth	.355	-	.233	-	-	-	-	.906
Shoulder width	.706	-	.170 [a]	.276	-	-	-	.630
Head length	.410	-	-	-	.395	-	-	.822
Head width	.210	-	-	-	-	.000	-	.978
Head height	.238	-	-	-	.395	.000	-	.887
Hand squeeze	.322	-	-	-	-	-	-	.947
Lung capacity	.645	-	-	-	-	-	-	.764
Total variance	4.977	2.103	1.058	.152	.312	.000	.266	8.132
Per cent variance	29.3	12.4	6.2	.9	1.8	.0	1.6	47.8

[a] Insignificant.

TABLE 7

MEANS AND VARIABILITIES OF THE DISTRIBUTIONS OF RESIDUAL CORRELATIONS FOR EACH AGE GROUP

Age	Mean	Standard Deviation	.6745 S.D.	P.E.$_{r=0}$
7	+.001	.044	.030	.049
9	+.003	.045	.031	.046
11	-.002	.048	.032	.044
13	+.001	.052	.035	.045
15	+.001	.056	.038	.038
17	-.001	.056	.038	.052

criterion of the insignificance of the residuals (4, p. 57), but is possibly too low a criterion, for the factor loadings are not raw correlations but are derived from them and might be expected to be subject to chance errors greater than those of corresponding raw correlations. The factor patterns given in Tables 1 to 6 appear to reproduce the tables of correlation with a degree of accuracy slightly greater than might be expected in view of the probable errors of the indices involved.

The permissive character of any factor analysis from the statistical point of view has been granted. In support of the scheme of factors here presented, it can be said that it fits the observed data, i.e., the tables of correlations, and that it has the advantage of reducing a large set of facts to a parsimonious description. The hypothesis of a general factor plus two independent group factors seems to present a neater and more parsimonious and interpretable picture of the observed data than do the factor systems derived from similar sets of data by workers (2, 5, 6, 7) who have used the multiple-factor methods and who present overlapping group factors each of which has significant weightings in such a variety of measurements as to make its interpretation very difficult.

Wright analyzed the intercorrelations of various skeletal measurements of several populations of rabbits and fowl by still another statistical technique, that of path coefficients. He found that the influence of the general size factor predominates, but that the residuals indicated the existence of group factors for the head, the forelimbs and hind limbs collectively, the hind limbs separately, and for the wings in fowl (10, p. 619).

THE CONSISTENCY OF THE FACTOR PATTERNS

The general factor loadings of the linear variables are on the whole higher than those for the cross-sectional measurements at all ages except seventeen. In other words the linear measurements are more highly correlated with the general factor at the early ages, and especially at age eleven, but the trend begins to reverse at this point, and by the age of seventeen the cross-sectional measures correlate more highly with the general factor. If it is assumed that this general factor is a mathematical statement of some underlying genetic or environmental cause (or causes operating as a unit), which determines the general size of the various parts, it apparently operates differently after the age of eleven than before it.

This change in the factor loadings from one age to another raises pertinent questions which the data at hand cannot answer. Are the factors indicated in one pattern the same as those indicated in another? Are the factors unitary or compound? Do the underlying factors determining growth change from age to age, or are the factors really the same, but our measurements of these factors obscured in varying degrees at varying ages, by the fact that two or more factors are operating in the same direction at one period but not at another, or by other difficulties?

The fact that the factors are as much alike as they are from one age group to another (that the same group factors emerge in each pattern and that the loadings are as consistent as they are) is some indication that there are real underlying factors of which our statistically determined factors are at least useful approximations, and that these underlying factors are constant. The problems arising in the task of estimating the size factors will throw additional light on this question of the consistency of the factors.

THE GROWTH OF THE FACTORS

As a basis for the calculation of the regression equations from which the factors might be estimated for individuals or groups of persons, three composite variables were set up, all the measurements which correlate with the factor β being combined into a composite variable B, all those which correlate with the factor γ being combined into a composite variable C, and the remaining five measurements into a composite variable D. The general factor and the group factor β were then computed from a seven-rowed correlational matrix consisting of the five variables of the β group in their original form and the composite variables C and D, while the group factor γ was computed from a 9-rowed correlational matrix consisting of the seven variables of the γ group in their original form and the composite variables B and D. Harman (3) has shown that there is small loss of reliability in such a procedure.

Each factor pattern, of course, gives a different equation of estimate, applicable directly only to the age group from which it was obtained. If any growth of factors is to be traced it is necessary to select one equation and apply it to girls of all age groups.

The equations are first determined in a form applicable to the standard scores in the various measures. In the process of reducing them to a form applicable to raw scores in the original measurements, the standard deviation of the measurements is used. Since the equation finally selected was to be applied not to any one age group but to all, new coefficients of standard deviation were calculated for each measurement by throwing the distributions for all age groups together and computing the standard deviation of the distribution of each measurement among the entire population studied.

The six equations for each factor were applied first to sample groups of girls of certain age groups to determine the correlation between estimates made by the different equations, and then to the average of each age group to determine whether they revealed similar trends of growth of the factors.

Estimates of α by three different equations gave correlations ranging

from .91 to .99+ for various age groups, and the growth curves were so similar as to indicate that it made little difference which equation was used.

The estimates of the group factors, as might be expected, appear to be considerably less stable than those of the general factor. The six different equations for the estimation of β are similar in some respects but the differences in the weightings of the measures within the β group are noticeable. Estimates for a sample of 34 girls of the nine-year-old group by two of these equations gave a correlation of .748 ± .048. It is therefore much less certain whether it is justifiable to use any one of the six equations for estimates of β at all ages. However, if any growth is to be traced, some equation must be selected.

The mean values of the estimates of β for each age group as calculated by each of the six equations are shown in Table 8 and graphically in Figure 1, together with the average of the estimates at each age.

Estimates of β based on the equation for the eleven-year-old group show the greatest deviation from the typical form of the curves of mean estimate. The equation for $\bar{\beta}_9$ gives results most closely agreeing with the average trend, and has a higher reliability (R = .906) than has the equation for $\bar{\beta}_7$ (R = .782) which gives results almost equally close to the average trend. $\bar{\beta}_9$ will therefore be used hereafter in this report for estimating the factor for individuals or groups. It must be admitted, however, that the differences between the different regression equations for β, the lack of high correlation between the estimates by two of them, and the differences in these growth curves all throw doubt on the advisability of attempting to use one equation of estimate at all ages.

The regression equations for the estimation of γ show even less reliability than those of β, as measured by the multiple correlation coefficients of the regression equations. The correlation between estimates of γ by the equations for $\bar{\gamma}_9$ and for $\bar{\gamma}_{15}$ for a sample of 34 girls of age nine is, however, practically the same, .758 ± .048, as the corresponding correlation for β estimates.

The mean value of the estimates of γ for each age group as calculated by each of the six equations is shown in Table 9 and in Figure 2, where the average value of the six estimates at each age is also shown for comparison.

The curve produced by the use of the equation for $\bar{\gamma}_{11}$ deviates most widely from the typical form of these curves. The other five are fairly similar in shape. The equation for $\bar{\gamma}_{15}$ most closely approximates the average curve of growth for these estimates of the factor γ, and has been selected for future use in estimating the factor.

TABLE 8
MEAN ESTIMATES OF β FOR EACH AGE GROUP, ACCORDING TO SIX DIFFERENT EQUATIONS

Age	$\bar{\beta}_7$	$\bar{\beta}_9$	$\bar{\beta}_{11}$	$\bar{\beta}_{13}$	$\bar{\beta}_{15}$	$\bar{\beta}_{17}$	Average
7	20.00	20.00	20.00	20.00	20.00	20.00	20.00
9	21.50	21.01	21.20	21.06	21.43	21.59	21.30
11	22.54	21.61	21.65	21.69	22.54	22.89	22.15
13	23.16	22.20	21.62	22.06	23.40	23.80	22.71
15	22.87	22.06	20.97	21.79	23.33	23.80	22.47
17	22.65	21.91	20.65	21.64	23.14	23.58	22.26

TABLE 9

MEAN ESTIMATES OF γ FOR EACH AGE GROUP, ACCORDING TO SIX DIFFERENT EQUATIONS

Age	$\bar{\gamma}_7$	$\bar{\gamma}_9$	$\bar{\gamma}_{11}$	$\bar{\gamma}_{13}$	$\bar{\gamma}_{15}$	$\bar{\gamma}_{17}$	Average
7	20.00	20.00	20.00	20.00	20.00	20.00	20.00
9	20.22	20.10	19.66	20.22	20.11	19.96	20.04
11	20.93	20.58	19.57	20.79	20.57	20.33	20.46
13	22.06	21.56	20.47	21.84	21.65	21.33	21.48
15	22.91	22.20	21.12	22.35	22.13	21.77	22.08
17	22.97	22.54	21.52	22.33	22.12	21.74	22.20

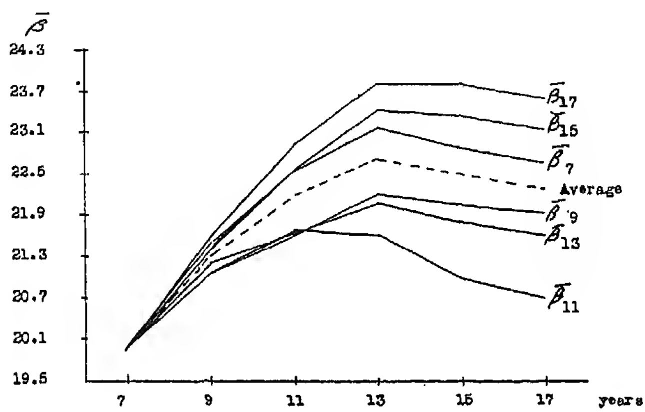

Fig. 1. Mean estimates of β for each age level according to six different regression equations.

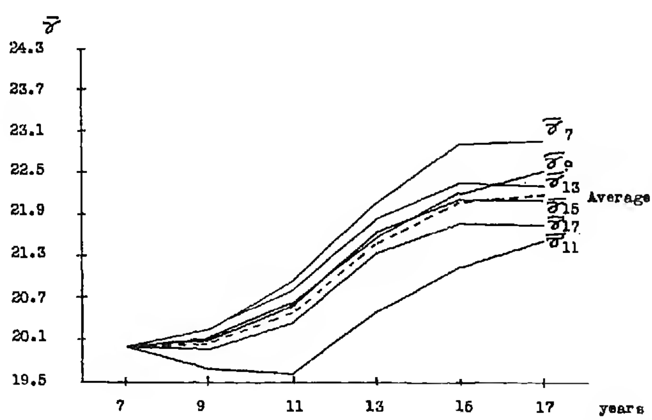

Fig. 2. Mean estimates of γ for each age level according to six different regression equations.

A comparison of the curves of Figure 1 with those for Figure 2 indicates typical differences between the form of the growth curves for the two group factors. The factor β shows rapid growth from the age of seven to that of eleven with a leveling off or decrease at thirteen. The γ factor characteristically shows very little growth from seven to nine, slight increases from nine to eleven, rapid growth from eleven to fifteen, with a leveling off at fifteen.

GROWTH OF THE FACTORS IN RELATION TO THE ADVENT OF THE MENARCHE

Since the advent of the menarche has been frequently shown to be closely associated with changes in the rate of physical growth, the girls of the present study, for whom the necessary data were available, have been subdivided into four sections according to their age at the menarche. Mean growth curves for each factor have been worked out for each maturity section. Section I includes girls for whom the menarche appeared during the eleventh year of age or earlier; Section II, girls for whom the menarche appeared during the twelfth year of age; Section III, thirteenth; and Section IV, girls for whom the menarche appeared after the fourteenth birthday.

The mean estimates for each maturity section at each age for both the general and group factors are shown in Table 10 and in Figures 3, 4, and 5. Since the evidence which has been presented suggests that estimates of the general factor may be made with high reliability by equations derived from any age group, the equation $\bar{\alpha}_{9b}$ (derived for the nine-year-old girls with the linear variables in their original form and the others in two composites) has been arbitrarily selected for the estimation of α. The estimates of the two group factors have been made by equations $\bar{\beta}_9$ and $\bar{\gamma}_{15}$, but as has been noted the estimates of the group factors have low multiple correlations and the results obtained here for the group factors must be considered as suggestive only.

The growth curves for the general factor present a consistent pattern. The earliest maturing section exceeds the other three at age seven, noticeably increases its superiority at age eleven, and has largely lost its advantage by the age of fifteen.

The two middle sections have noticeably decreased the differences between themselves and Section I at age 13, but the section latest in maturing is still considerably behind the other sections at that age.

The growth of the general factor, therefore, appears to be definitely and positively related to the stage of sexual maturity reached by the girls. The mean growth of a section of the girls in the general factor seems to be accelerated during the year of or just preceding the menarche, and retarded thereafter, the differences between the groups being negligible at the age of 17.

A very different picture is presented for the growth of the group factor β. Differences between the sections are slight up to the age of 11. Thereafter the curves fan out in inverse order, Section IV having consistently highest place and Section I the lowest. In noting this superiority of Section IV at the later ages, it must be remembered that high estimates of β might be obtained from the use of the regression equation through large mean values of the height and limb measures which

TABLE 10

MEAN ESTIMATES OF THREE FACTORS IN THE PHYSICAL MEASUREMENTS OF GIRLS OF VARIOUS MATURITY SECTIONS

Age	Mean Estimates for All Girls in This Study	Mean Estimates for Section I (Menarche during 11th Year or Earlier)	Section II (Menarche during 12th Year)	Section III (Menarche during 13th Year)	Section IV (Menarche during 14th Year or Later)
		General Factor, $\bar{\alpha}_{9b}$			
7	20.00	20.40	19.36	19.27	19.25
9	22.44	22.90	22.39	21.92	21.78
11	24.99	26.59	24.93	24.46	23.64
13	27.39	27.99	27.74	27.14	25.96
15	28.57	28.55	28.78	28.52	28.35
17	28.92	28.90	28.90	29.04	28.80
		Group Factor, $\bar{\beta}_9$			
7	20.00	20.42	20.42	20.56	20.22
9	21.01	21.16	21.01	21.21	20.84
11	21.61	21.62	21.79	21.01	21.50
13	22.20	21.65	22.22	22.53	22.63
15	22.06	21.27	21.35	22.31	22.65
17	21.91	21.06	21.63	22.04	22.80
		Group Factor, $\bar{\gamma}_{15}$			
7	20.00	20.22	20.07	20.62	20.11
9	20.11	21.14	19.95	20.12	20.14
11	20.57	21.72	20.32	19.98	20.58
13	21.65	23.03	22.10	21.30	21.09
15	22.13	22.97	22.17	21.99	21.65
17	22.12	22.81	22.33	22.21	21.81

enter positively into the equation, or through low mean values of the weight and cross-sectional and other measures which enter negatively into the equation, or through both. A study of the means of the sections in the original measurements showed, for these groups as for similar ones studied by Shuttleworth (9), that the later maturing girls do not attain superiority over the early maturing girls until the age of seventeen in the linear measures, but that they consistently lag behind in the cross-sectional measures from 11 to 17. The estimates of β are, therefore, not so much indicative of linear growth itself, as of a linear type of body, i.e., high mean estimates of β are characteristic of a group of girls who tend to have lighter weight and smaller cross-sectional measurements for the same height and limb lengths.

Interpreting β, then, as a measure of linearity of type, Figure 4 indicates that between the ages of 7 and 11 the girls of all four sections are stretching up, becoming more linear in type, and without significant differences between the sections. With puberty this tendency is checked, the filling out process becomes relatively more important and the mean estimates for the sections indicate a decrease in linearity. This is true for Section I after 11, these girls having reached puberty

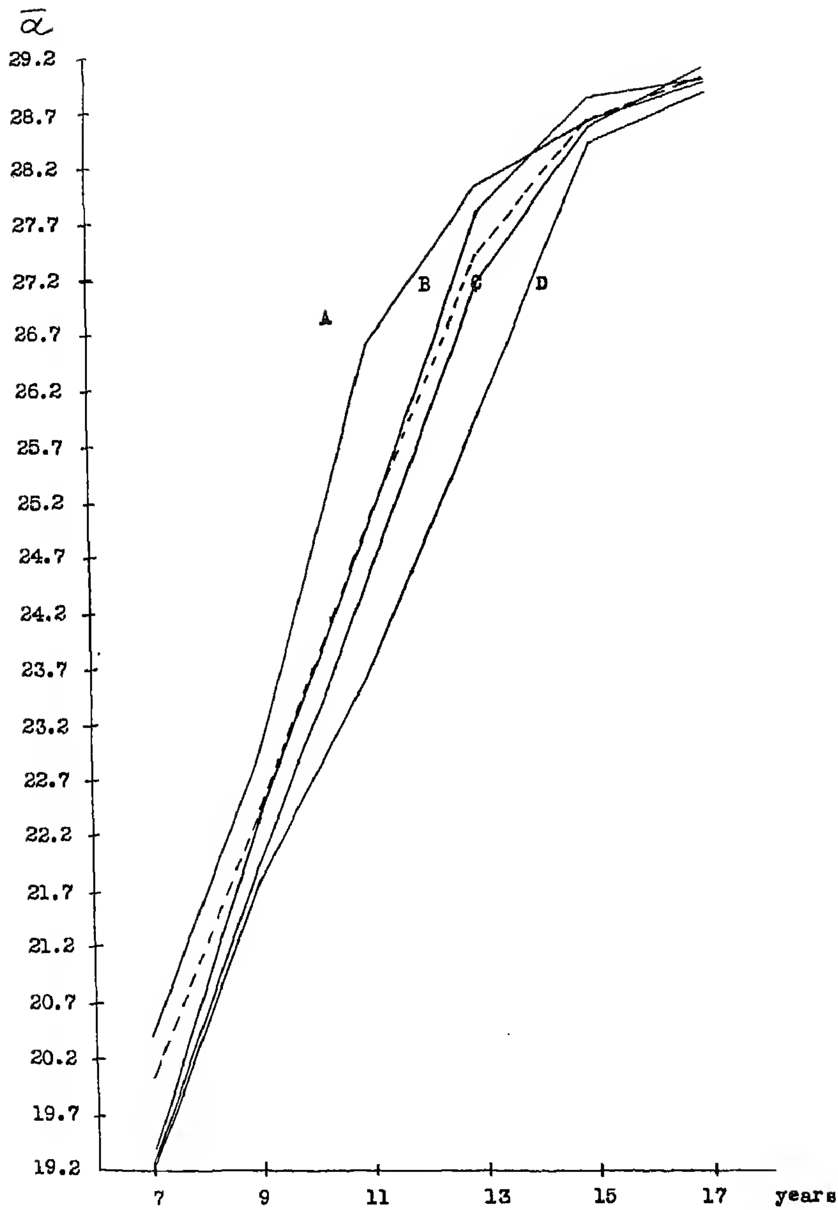

Fig. 3. Comparison of the mean growth of the general factor for four maturity sections and for all subjects (according to the equation for $\bar{\alpha}_{9b}$).

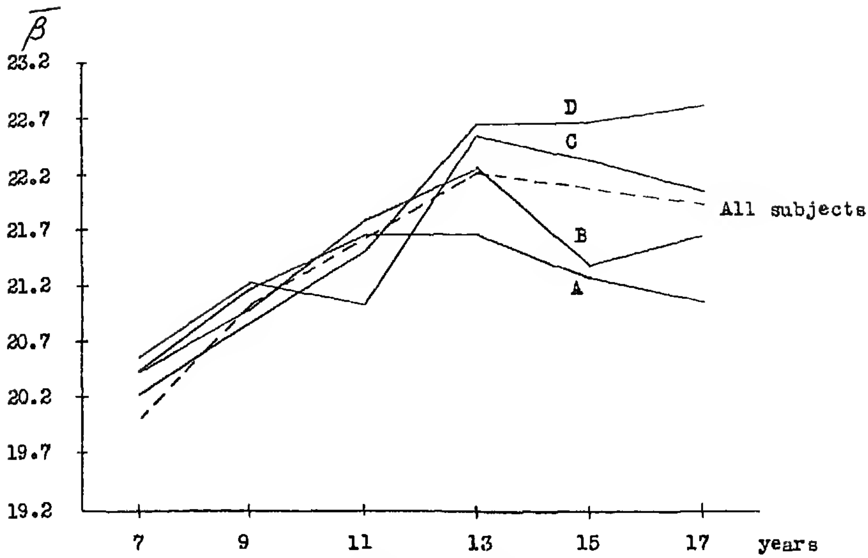

Fig. 4. Comparison of the mean growth of the group factor β for four maturity sections and for all subjects.

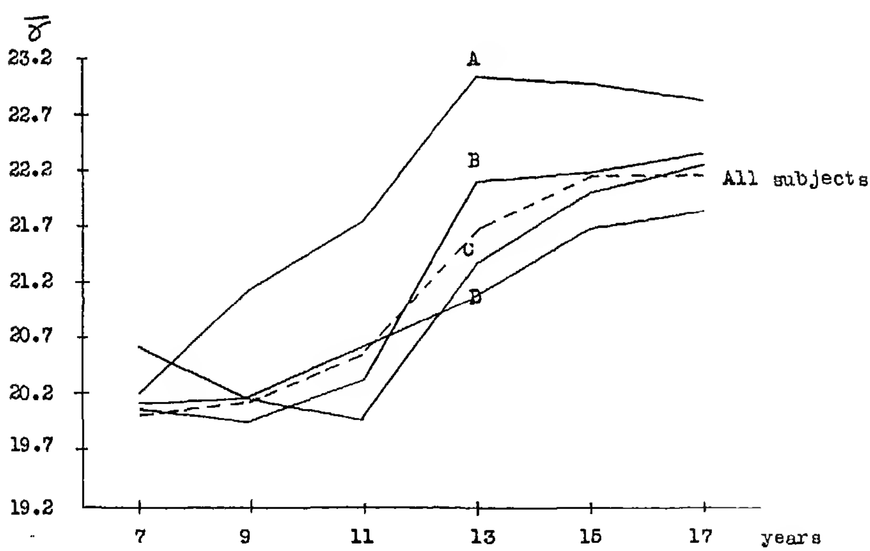

Fig. 5. Comparison of the growth of the group factor γ for four maturity sections and for all subjects.

at or before 11. For Sections II and III this is true at age 13, at which age or earlier these girls had attained puberty. Only for Section IV, the latest maturing group, does the tendency to linearity not only persist but increase up to the limits of this study.

The girls of the latest maturing section appear, therefore, to be on the average permanently of a more linear type than are the girls of the earlier maturing sections.

These deductions from the β curves are verified by the complementary picture shown in the γ curves. High estimates of γ would be produced either by high mean values of the cross-sectional measures which enter positively into the regression equation, or by low mean values of the height and limb and other measures which enter negatively into the equation, or by both conditions. The relative weightings of the different measures in the two regression equations are of course different and some measures enter negatively into both equations, so that the factor is by no means merely a measure of the obverse of β. The factors in fact are by hypothesis statistically independent. The factor γ is, however, a measure of the relationship of cross-sectional measures to height, rather than of cross-sectional measures alone.

The three sections II, III, and IV, all appear to follow a γ -growth curve similar to that for the whole group, showing little change from 7 to 11 with rapid increase in the prepubertal years and a retardation in the rate of increase thereafter. The girls who reach puberty earliest, however, show a very different trend of growth in this factor, with rapid increase in γ all the way from 7 to 13, during both prepubertal and one or more postpubertal years, and maintain a wide superiority over the other sections in respect to this factor, at least through the age of 17.

If the γ factor is interpreted as an expression of some underlying influence tending to accelerate growth in weight and the hip and chest measurements more rapidly than growth in the other dimensions, in other words of a tendency to stockiness of build, then the curves of Figure 5 may be said to indicate that the girls who will reach puberty at an early age show this tendency from the age of 7 on, while girls of the later maturing groups do not show this tendency till after 11. The girls of the earliest maturing section show persistently a much higher index in this trait than do the other sections, through the age of 17. For girls who will not mature so early, this factor does not come into operation till after 11. Thereafter it produces its effect most rapidly in the prepubertal years, the rate of change in body type produced by it being sharply decelerated at about the age of puberty.

SUMMARY

Factorial analyses have been made by the bi-factor technique of six tables showing the intercorrelations of seventeen physical measurements of girls of the ages respectively of seven, nine, eleven, thirteen, fifteen, and seventeen.

At all age levels studied a general size factor may be postulated which accounts for from thirty to fifty per cent of the total variance of the seventeen measurements.

The general factor as derived from the correlation matrices for the

various age groups is fairly consistent although at the earlier ages the linear measures correlate more highly with it and at the later ages the cross-sectional measures have higher loadings. The differences are not so great, however, but that the estimates of the general factor based on the six different factor patterns present very similar mean growth curves for the whole group, and that estimates made by one correlate highly with estimates made by another.

At all age levels studied, two group factors are apparent after the effect of the general factor is removed. One of these is found in the residual correlations of height, span of arms, length of forearm, and length of lower leg. Sitting height proved not to be significantly correlated with this factor. The proportion of the variance ascribable to this factor varies from 3.6 per cent at age 7 to 12.4 per cent at age 17. Estimates of this factor by regression equations calculated from different factor patterns do not correlate as highly with each other and do not give as similar growth curves as do the various estimates of the general factor.

The other group factor γ is found in the residual correlations for weight, bi-iliac and bi-trochanteric diameter, and chest girth, width, and depth. Shoulder width was the only cross-sectional trunk measure which did not have significant correlations with this factor at all ages, and it does have at ages 9 and 11. Factor loadings and regression weights for this factor also are not consistent from age to age. Its contribution to the total variance varies from 6 per cent for the seventeen-year-old group to 11.8 per cent at age 9.

The present data indicate that these two factors do exist at all ages, but it is probable that the measures used do not give sufficiently pure estimates of the group factors to make their prediction of much value at the present time.

Estimates of the general and group factors for girls of different maturity sections indicate that the general factor is closely related to the stage of sexual maturation. Growth curves for the estimates of the general factor show rapid growth in the years just preceding puberty and deceleration thereafter, with no permanent superiority for the early maturing group.

The group factors appear to be indicators of body type, the β factor giving crude measures of some underlying factor tending toward linearity of body type and the γ factor giving crude measures of some underlying factor tending toward stockiness of body type.

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AN ANALYSIS OF THE VARIANCE OF CONFLICT BEHAVIOR IN PRESCHOOL CHILDREN[1]

MERRILL ROFF AND LOUISE ROFF[2]

Most studies of the behavior of children in preschool age have been made with groups in university nursery schools, who come from families that are an extremely selected sample of the total population. With the development of W.P.A. nursery schools it has become possible to observe children who have backgrounds markedly different from those of children whose parents are in the professional or upper business groups. If we compare with university nursery school children the W.P.A. school populations in the "steel area" of South Chicago, for example, or in a negro area in East Chicago, or in a southern Indiana town, ordinary observation suggests that there are important differences in the behavior of the children from these various groups. On the other hand, we have found in the literature few specific hypotheses concerning such differences.

In most cases, investigations of children's behavior have treated the group studied simply as a more or less random sample of the whole population of children, and have tried to explain differences in behavior, as far as possible, by reference to a few simple, general, and abstract psychological concepts such as age, sex, level of intelligence, etc., which would operate more or less uniformly through the whole population. It seemed obvious that the groups mentioned above were not random samples of a general population, but were markedly selected and of interest because of this diversity. Some of the factors operative in the selection of children in these groups are easily apparent, for example, proximity to the nursery school and economic level. There are other factors of selection which are not so apparent, such as interest of the parents in the welfare of the child, experience or acquaintance with nursery schools, occupation and duties of the mother, and so forth.

If we should observe all the existing groups of nursery school children, we would find similarities in behavior which would cut across differences in background and setting. It would be possible to find groups of children who were so diverse in intelligence that the groups would not overlap at all, but they could all be placed on the same intelligence scale. It would probably be possible to find groups who would differ as much in other psychological or personality characteristics, but this region is almost completely uncharted. Many workers in the field of intellectual abilities and language have made rough divisions according to socio-economic status and studied differences in performance related to these groupings. A few studies, i.e., Francis and Fillmore (6) and Springer (21), have reported differences in general personality adjustment in school age children from widely different economic levels. Gesell and Lord (7) gave tests and ratings on certain personality characteristics to eleven pairs of children; one member of each pair was from a superior economic group and one from a low economic group. Goodenough (9

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[2]*The authors wish to acknowledge the assistance received from the Indiana University Research Fund, and to express their appreciation of the cooperation of members of the educational division of the W.P.A.*

and 10) has also noted differences in shyness, negativism, and distractibility during mental tests which were associated with economic level of the parents. Jersild and Markey (14) and Dawe (4) have reported differences in amount of conflict behavior shown by children of upper and lower economic groups. On the whole, however, the incidence of certain behavior characteristics in different groups of children has been attacked only in a very general manner or has been a matter of incidental observation in studies primarily concerned with other questions.

The term "socio-economic" is, in practice, usually employed as if it meant merely "economic," due to the ease of differentiation on the basis of income. It is a relatively simple task to classify families on the basis of their economic or occupational status, but to give a description of the "socio-" and psychological factors associated with such differences which might be expected to influence (for example) the emotional development of the children involved is a much more difficult problem. A related classification of the factors which influence child behavior, which is receiving increasing emphasis, is that into cultural and non-cultural. Specific reference to cultural influence is made by Murphy (20) in her study of sympathy behavior, in which "cultural" is a general term opposed to "constitutional," as one of the two main factors in behavior. Undoubtedly some of the influences on children's behavior would be called "cultural" with almost any definition of the term, but it is also true that many of these non-constitutional influences would be considered non-cultural by any definition less broad than that of Lowie (18), who defines culture as equivalent to all acquired behavior and then defines psychology as the study of the "inborn attitudes and behavior of human beings." A more restricted definition of culture, which is representative of a somewhat different point of view, is that given by Linton: "A culture as distinct from culture in general, may be defined as the sum total of the behavior patterns, attitudes and values shared and transmitted by the members of a given society" (17, p. 425). This definition permits the development of a conceptual framework which seems more promising for psychological problems than a constitutional-cultural dichotomy. As Linton points out: "Seen from his own point of view, the setting of the individual consists not of abstract culture patterns but of concrete things and people. . . The actual behavior of a father toward his son will be a function not only of the culture patterns but also of the father's temperament and of the attitudes between father and son which have been developed through previous experience. Thus the pattern may require that the father punish his son for a certain offense in a certain way, but whether the punishment is as light as possible or as heavy as possible, administered with regret or obvious enjoyment, will depend on non-cultural factors" (17, p. 436). Anyone interested in a thorough treatment of this problem may be referred to J. R. Kantor's An Outline of Social Psychology (15).

We know, in a general way, that both "cultural patterns" running through a "total culture" and differences in customs and attitudes which are peculiar to certain groups of a population or even to particular families are important determinants of the child's social behavior as they influence, or are reflected in, the behavior of the parents or other persons toward the child. Our knowledge of how these factors influence specific types of behavior is very limited. What is needed is

a method of analysis more concrete and more flexible than those which have been used in previous studies, which will bring out differences between specific groups in various kinds of psychological activities. The different groups of adults who are parents of children in specific nursery schools will vary from each other and from other adult groups in the population in certain known ways. For instance, they will vary as groups in level of intellectual ability, in amount of formal education, in health, in types of recreation enjoyed, in stability of living conditions, and in doctrines of child training, to name but a few variables. What implications these or other differences among subgroups of the population may have for the development of specific types of behavior in the children of these adults have not yet been determined.

The group of children which was most available to us for continued observation was one in a W.P.A. nursery school in Bloomington, Indiana. In informal observation, the children as a group seemed to show less attention-getting behavior, less resistance to the suggestions of the teachers, more willingness to share materials and to include others in play, and smaller amount of talking than the children we had seen in university nursery schools. We selected for systematic study an apparent difference in conflict behavior, primarily because the careful study of conflicts by Jersild and Markey (14) had established a procedure which could be duplicated, and because their observations covered three different nursery schools with which our group could be compared. We also made a smaller number of systematic observations in a W.P.A. nursery school in Chicago.

Jersild and Markey describe the groups in which they studied conflict behavior as follows (14, p. 6):

> Group A. Seventeen children, including eleven boys and six girls, with an average age of 29.1 months and an age range of 22 to 36 months at the mid-point of the observations, members of a nursery school associated with the Child Development Institute of Teachers College.
>
> Group B. Nineteen children, including thirteen boys and six girls, with an average age of 42.7 months and an age range of 33 to 50 months at the mid-point of the observations, members of the Guidance Nursery group at the Child Development Institute.
>
> Group C. Eighteen children, including six boys and twelve girls, with an average age of 38.3 months and an age range of 26 to 48 months at the mid-point of the observations, members of the nursery school group of Manhattanville Day Nursery.

They made a continuous record of the behavior of each of the fifty-four children for ten fifteen-minute periods, of which eight periods were taken out-of-doors and the remaining two indoors. For fifty of the children the observations were spread over a period of three to five months. "The aim was to record all activities that might be construed as belligerent, defensive, offensive, resistant, or provocative under the most liberal interpretation of these terms" (p. 10). "Each act that constitutes an initial act of aggression in a sequence of interchanges, or in

an unretaliated attack by one child upon another . . . marks the beginning of a new conflict" (p. 29). Each child would also appear in the records when he was not the object of direct observation, if he came into conflict with a child who was being observed. These conflicts were totaled under the heading "indirect observations." There was an agreement of 97 per cent between different observers on the total number of conflicts; reliability coefficients of .87 and .90 were obtained with two different arrangements of the total values for direct and indirect observations.

When the three different nursery school groups were compared, Jersild and Markey found marked differences in the frequency of conflicts. In Table 1 the average number of conflicts per child is given for all the groups combined and for each group separately. It is clear from this table that there are marked differences in conflict frequency between the three groups with the older nursery school group connected with the Child Development Institute showing the least conflicts and the day nursery group the most. Jersild and Markey point out that their results "indicate that the character of the group, quite apart from the factor of age, may have a telling effect on the trend of the findings. The general conclusions emerging from the present study would be quite different on many points had the study been confined to groups similar to Groups A and B" (pp. 85, 86). From their analysis of the differences in the make-up of the populations of these three groups and the general characteristics of the nursery schools, they come to the conclusions that the following factors "may (with varying degrees of assurance) be regarded as contributing to the higher frequency of conflicts in Group C as compared with Groups A and B: 1) socio-economic status; 2) intelligence; 3) amount of play space and equipment; 4) amount of teacher interference and number of teachers in attendance; 5) relative frequency of teacher interference with the children; 6) national background" (p. 99). The authors believe that the "role played by teachers is one of the most important factors, but a final statement as to how significant each of the various factors is, or a final estimate of the weight of each factor cannot be given" (p. 99). Further consideration of the differences between these groups, and possible factors related to frequency of conflicts will be given in connection with the results from our observations.

PROCEDURE

The group for which we have a complete set of observations consisted

TABLE 1

AVERAGE NUMBER OF CONFLICTS PER CHILD DURING TEN FIFTEEN-MINUTE PERIODS AS GIVEN BY JERSILD AND MARKEY

	All Groups Combined	Group A	Group B	Group C
Direct observations	30.9	30.2	16.0	38.1
Indirect observations	30.8			
Total direct and indirect observations	58.0	62.1	34.3	80.7

of seventeen children, including nine boys and eight girls, with an average age of 39.1 months, an age range of 20 to 50 months (S.D. 6.4 months) at the mid-point of the observations, members of the W.P.A. nursery school in Bloomington, Indiana. All the parents of both sexes were native Americans, and most of them came from families which had lived in southern Indiana for several generations. There is considerable interrelationship and shifting back and forth of the people in town and of the people engaged in farming in the surrounding country. The neighborhood from which the children come is a "working class" neighborhood made up of individual houses. One of the main industries of the county is quarrying and milling limestone. Five of the fathers worked at one kind of stone cutting or another, when work was available. (The limestone industry has been somewhat depressed for a number of years.) The rest of the fathers gave their occupations as follows: grocery clerk, clerk in bakery, laborer, W.P.A. painter, round-house worker for a railroad, and one deceased father had been a railroad ticket agent. The mothers were primarily housewives, although some of them worked occasionally as clerks in stores or did domestic work, and one had occasionally taught as a substitute in grade school. No one of them was employed steadily outside the home. The actual monthly income for the families was not known exactly, but was in most, if not all, cases less than $90 a month. The average number of years of formal education for the fathers was 9.8, with a range from 8 to 13, and for the mothers was 11.9, with a range from 8 to 14 (one mother had had two years of college work). The average number of children per family was 3.2 with a range from 1 to 7. There was but one only child. The average birth order for these children was 2.6.

For the variables amount of income, type of occupation, amount of formal education, and size of family, the families from which these children come are probably representative of a rather large segment of the population of the country, though differing markedly from the families from which most university nursery school groups draw their members.

Stanford-Binet tests were given to twelve of the seventeen children. The average I.Q. for these twelve was 107, with a range from 89 to 125. More than half the children fell between 100 and 110. Three, two of them siblings, had I.Q.'s in the 120's.

The nursery school itself was adequately equipped, though definitely less well provided with play equipment than a university nursery school. There were three medium-sized rooms for inside activities, and a small playground for outdoor play. There were two teachers connected with the school, and both were present during nearly all of the observations.

We followed the observational procedure of Jersild and Markey as closely as we could. "Each child .....was observed during ten distributed 15-minute periods.....The observer followed one child at a time and recorded, as fully as possible, the behavior of this child in his contacts with other children as well as the behavior exhibited by other children in their contacts with him. The record was taken in the form of a running, diary account....." (p. 152). Our records were made in short-hand but were otherwise similar. Observations were made during the free play period in the forenoon. More than half the observations, however, had to be taken inside, as bad weather conditions and clothing which was

inadequate for extended periods of outdoor play, in the case of a few of the children, prevented outdoor play most of the time during the first two months of observation. Since conflicts were more frequent indoors than out, this results, probably, in increasing our total conflict frequencies as compared to those of Jersild and Markey's groups.

In the analysis of our records we followed the method of Jersild and Markey, and took their definition of conflict; "For the purpose of this study, a conflict is defined as any instance in which one child attacks another's person or by word or deed interferes with the person, activities, or possessions of another, or threatens by word or gesture to do so, or endeavors by force or verbal demands to possess another's belongings, or direct another's activities in opposition to the apparent desires of the child against whom the aggression is made . . . Contacts that involved seemingly accidental bumps and collisions, or apparently playful interchanges of hits and pushes were not treated as conflicts" (pp. 152, 153).

For our group we obtained the following results:

	Average frequency of conflicts	Range	Sigma
Direct observations	15.4	3-34	8.2
Indirect observations	15.5	1-39	
Total direct and indirect combined	30.8	8-61	16.2

The average number of conflicts in direct observation is approximately half that of the average (30.9) of Jersild and Markey's three groups combined, and that of the total (direct plus indirect) is slightly more than half their value (58.0). The mean and the standard deviation fall near those of Jersild and Markey's B group. If we had had the same proportion of observations outdoors as they had, the mean probably would have been one or two units lower, since we found more conflicts in the observations taken inside. (Dawe (4) and Caille (3) also found a tendency for more quarreling and resistance indoors.) We are using the obtained mean without correction in order to avoid any over-accentuation of differences between the groups.

We have an incomplete set of observations from a W.P.A. nursery school in Chicago, which were obtained in the summer of 1938. Since we were able to complete only three observations for most of the children these results are not included in the analysis of variance made later on. However, though the figures obtained for individuals are not very reliable because of the small number of observations, the totals for the group as a whole are consistent enough to warrant a brief summary of the results obtained. With the Bloomington group it was found that the average number of conflicts per observation was 1.4 for the first three observations for each child, and 1.5 for the last three observations for each child, as compared with an average of 1.5 for the total ten observations. For the Chicago group, the average per observation was 2.3 for the combined scores of the first and last observations for each child; 1.8 for the second observation for each child, and 2.1 for the total observations. These figures would seem to indicate that on the basis of as few as three observations per child the group as a whole can be fairly accurately ranked in comparison with other groups on the basis of total

number of conflicts.

This group consisted of sixteen children, nine boys and seven girls, with an average age of 41 months, and an age range of 32 to 51 months, with a sigma of 5.2, at the mid-point of the observations. Five of the fathers were of foreign birth (2 Italian, 1 German, 1 Norwegian, 1 Scottish) and four of the mothers (3 Irish, and 1 Canadian). As far as possible the national grouping of the rest of the parents, who were American born, was determined. Including both the children with foreign-born parents and those whose parents were of foreign extraction, there were five children with Italian ancestry, four who were partly of Irish extraction, one with part German, one with part Scottish, one with part Canadian, and one with part Norwegian ancestry. On the whole, with the exception of the five children of Italian extraction, the group was made up of children of North European extraction. The neighborhood was a relatively stable one, made up largely of single or double houses. Two of the fathers were on W.P.A.; two were unemployed; one was a grocery clerk; one, a bartender; one worked in a bakery; one, as a clerk in a railroad office; two were factory workers; one was a truck driver; one, a bill poster; and one was a small storekeeper. Six of the mothers worked outside the home part of the time. In the case of twelve of the children the average monthly income of the family was known. It ranged from $47 (for one family on relief) to $120 a month, with an average monthly income for the group of $82 a month. The average number of years of formal education for the fathers was 9.3 years, with a range from 6 to 12, and for the mothers, 9.7, with a range from 6 to 14 (one mother had two years of business college). The average number of children per family was 2.6, with a range from 1 to 6. There were five only children, and five with only one living sibling. The mean birth order for the sixteen children was 2.3.

Stanford-Binet tests were given to nine of the children. The average I.Q. was 114 with a range from 88 to 140; three of the children had I.Q.'s above 120, and only one fell below 100.

The nursery school was located in a settlement house and received some support from it. There were three teachers altogether, and at least two of them were present during nearly all the observations. The observations were all taken during the outdoor free play period. The playground was large, more than twice the size of that of the Bloomington nursery school. The play equipment was more than adequate, definitely better than that for the Bloomington group and not much below the average of the university nursery schools which we have seen.

The observational procedure was the same as for the other group except that all the observations occurred in the outdoor play period, and only three observations were obtained for most of the children.

The results given in the table below were obtained by multiplying the observed conflict frequency of each child to obtain the estimated frequency if he had been observed for ten periods, so that the results would be directly comparable with those of the other groups.

	Average frequency of conflicts	Range	Sigma
Direct observations	21	7-43	10.5
Indirect observations	24	7-57	
Total direct and indirect	45	17-100	18.8

In order to facilitate comparisons between the different groups three tables are given below. Table 2 gives a summary of the frequency of conflicts in each of Jersild and Markey's three groups and in our two. Table 3 gives a summary of the average number of conflicts per observation for direct observations according to six-month-age levels. The lowest age levels were omitted because there were too few children observed at these ages to afford satisfactory comparison. Table 3 not only indicates no consistent trend in frequency of conflict with age, but also shows that the different nursery schools maintain their relative ranking fairly consistently at different age levels. Jersild and Markey obtained rank-difference correlations between age and number of conflicts of 0.02 in group A, 0.14 in group B, and -0.34 in group C. Other studies have noted some age differences. Green (12) found the most quarreling at three years and Caille (3) found that resistant behavior was most frequent at the three-year level. Dawe (4) on the other hand, found that quarreling decreased with age.

Jersild and Markey investigated also the relationship between number of conflicts and intelligence ratings, and obtained the following correlations:

Test	Group A	Group B	Group C
Minnesota Preschool	-.45	.00	-
Kuhlmann-Binet	-.50	-.02	-
Merrill-Palmer	-.15	-.40	-.24

Dawe (4) found a rank-order correlation between frequency of quarreling and I.Q. of -.17. In general, there seems to be a slight, though not consistent, tendency for brighter children to engage in fewer conflicts

TABLE 2

AVERAGE NUMBER OF CONFLICTS PER CHILD IN FIVE DIFFERENT NURSERY SCHOOLS

	Group A nursery school*	Group B nursery school*	Group C nursery school*	Blooming-ton W.P.A. nursery school	Chicago W.P.A. nursery school
Number of children	17**	19	18**	17	16
Age range in months	22-36	33-50	26-48	20-50	32-51
Average age	29.1 (4.3)	42.7 (4.8)	38.3 (7.8)	39.1 (6.4)	41 (5.2)
Conflicts in direct observations	30.2 (8.5)	16.0 (8.0)	38.1 (9.1)	15.4 (8.2)	21 (10.5)
Total conflicts direct and indirect observations	62.1 (24.8)	34.3 (15.5)	80.7 (24.1)	30.8 (16.2)	45 (18.8)

* These groups are the three groups studied by Jersild and Markey.
** In Group A and Group C one child was not counted in the indirect observations.
Figures in parentheses represent sigmas.

TABLE 3

AVERAGE NUMBER OF CONFLICTS PER CHILD PER 15-MINUTE PERIOD OF OBSERVATION AT SUCCESSIVE SIX-MONTHS AGE LEVELS

This table is based on direct observations only. Ages are represented in terms of the child's age at the time a given 15-minute observation was made, and the same child may be represented at different age levels.

	Age in months			
	30-35	36-41	42-47	48-53
Group A				
Number of 15-minute observations	68	9	0	0
Average conflicts per observation	3.3	2.3		
Group B				
Number of 15-minute observations	12	72	71	35
Average conflicts per observation	1.2	1.7	1.6	1.4
Group C				
Number of 15-minute observations	52	21	72	8
Average conflicts per observation	4.2	3.5	3.3	3.8
Bloomington				
Number of 15-minute observations	44	36	36	43
Average conflicts per observation	1.1	1.0	2.1	1.7
Chicago				
Number of 15-minute observations	8	18	14	6
Average conflicts per observation	2.0	2.2	1.9	2.5

than do duller ones.

Sex differences in our groups were found to be completely negligible. In the Bloomington group the average number of conflicts (direct and indirect observations) was 30.6 for the boys and 31.1 for the girls; in the Chicago group, the average for the boys was 44.6 and for the girls 46.3. Most studies, however, have reported sex differences. Jersild and Markey found a slightly larger number of conflicts for boys than for girls in all groups, but when the children in each group were matched for age, groups A and B, with a predominance of boys, showed more conflicts among the boys, and Group C with a predominance of girls showed a larger number of conflicts for the girls. The differences were small and statistically unreliable. They interpret their findings as indicative that the sex that is in the majority exhibits the most conflict behavior and believe that this is a function of the frequency of social contacts, since children of the same sex play together more than those of opposite sexes. Our results would not disagree with this hypothesis, as our groups were almost evenly divided between the two sexes. In the studies dealing with quarreling [Green (11 and 12) and Dawe (4)] , aggressive behavior [Caille (3) and Hattwick (13)] , resistant behavior [Caille (3)] , anger [Goodenough (8)] , and negativism during mental tests [Goodenough (9 and 10) and Mayer (19)] sex differences have been found, with boys showing more of the type of behavior studied. When Goodenough (9 and 10) in her study of negativism divided the children into two groups on the basis of socio-economic level, the group comprising the upper

three economic classes showed a marked sex difference with boys exhibiting more negativistic behavior, but the group from the lower economic levels showed only a slight sex difference, and the relative standing of the two sexes was reversed, with the girls showing more negativism. Levy and Tulchin (16) also found more resistant behavior among girls during mental tests in a group of children fairly representative of rural and small town populations, but the total amount of resistant behavior observed was not very great. These findings in the field of negativism during mental teets indicate the possibility that sex differences which may occur in upper economic groups may not necessarily be of the same order in groups of lower economic status. It is possible, therefore, that our finding of no sex difference is linked with the composition of the groups we studied.

The factors which Jersild and Markey thought might be of significance in explaining the differences between their groups are 1) socio-economic status, 2) intelligence, 3) amount of play space and equipment, 4) amount of teacher interference and number of teachers in attendance, 5) relative frequency of teacher interference with the children, and 6) national background. It is evident that economic status by itself is not a significant factor, as our groups were much more similar to the day nursery group than to the others in this respect and yet were relatively low in conflicts. Dawe (4) also found a slight tendency for children from lower economic groups to quarrel less (in a group composed of children from different economic levels). Since the "socio-" status of each group cannot be adequately defined, it is difficult to evaluate its contribution. Similarly, intelligence does not appear to have any close relation to number of conflicts. Both our groups had an average intelligence level near that of Jersild and Markey's group C, but their conflict frequencies differed markedly from that of the New York day nursery group.

We found no relationship between amount of play space and equipment and number of conflicts. Our Bloomington group was rather limited in both respects, whereas the Chicago group had much more play space and more equipment yet was higher in number of conflicts. Common experience indicates that the amount of play space and amount of equipment would be factors in extreme cases. It could be predicted with considerable confidence that three children forced to play in a closet would have more conflicts in a given period of time than the same three allowed to play in a sizeable yard, and similarly, it is probable that these same children would show more conflicts if provided with only one toy to play with than if provided with a number of possible play things. On the other hand, our data in conjunction with that of Jersild and Markey's show that amount of play space and equipment are, within a considerable range of variation, relatively unimportant in comparison to other influences.

Neither the number of teachers nor the amount of teacher interference with conflicts accounts for the differences between the five groups. The Group A school had twice as many teachers and the same percentage of conflicts interfered with by teachers as the Bloomington group, and had about twice as many conflicts. The Chicago group had markedly less interference by teachers than any other group, but falls in a median position in number of conflicts. The Group B school had five teachers as compared with two in the Bloomington school, and slightly more teacher

interference in conflicts, but was not below the Bloomington group in number of conflicts. Here again, either of these factors would undoubtedly be of importance in extreme cases, but they are not very influential within the limits of these five groups. It is possible, however, that the role of the teachers in children's conflicts may not be adequately estimated merely by number of teachers and the frequency of their interference in conflicts.

We can come to no conclusion concerning the effect of nationality as both of our groups were largely of North European extraction. We found no difference in number of conflicts between the five children of South European extraction and those of North European extraction in our Chicago group. (The figures were 44.2 and 45.8, respectively, for total frequency of conflicts.)

Table 4 summarizes the chief characteristics of the three Jersild and Markey groups and our two with respect to these factors.

ANALYSIS OF VARIANCE

The above considerations indicate a need for a more concrete and specific analysis than that in terms of age, socio-economic class, or other general category. One way in which a start can be made in this direction is to analyze the variance of the conflict frequencies into inter-group and intra-group variance, using the technique developed by R. A. Fisher (5).

An implicit and somewhat tautological-sounding assumption underlying this procedure as well as other work on individual differences is that all the members of a given population would be identical were it not for influences causing them to be otherwise. A measure of difference with several statistical advantages is the variance, or square of the standard deviation, of a population. If a population is made up of several sub-populations, each with its own mean, standard deviation, and variance, the variance of the total population is the sum of two quantities, 1) the sum of the variances of each sub-population around its own mean, known as the intra-group variance, and 2) the variance of the means of the sub-populations, known as the inter-group variance. Since the total variance is a sum, the two components can each be spoken of as contributing such-and-such a percentage of the total variance. If the means of the sub-populations differ little, so that the distributions of the sub-populations would largely overlap, then a large percentage of the total variance would come from the intra-group variance; this would mean that other factors than those by which the sub-populations were divided were responsible for the differences between members of the total population. Conversely, if the means of the sub-population were well apart, and their distributions overlapped but little, a major percentage of the total variance would come from the inter-group variance; this would mean that the factors which were the basis of division into sub-populations, or other factors associated with these, were primarily responsible for the differences between members of the total population.

The discussion above of the influence of age, sex, etc., would indicate that almost all of the total variance would be due to intra-group factors, when sub-populations are formed on the basis of age, sex, etc.

TABLE 4

SUMMARY OF CHARACTERISTICS OF FIVE NURSERY SCHOOL GROUPS

	Group A nursery school	Group B nursery school	Group C nursery school	Bloomington W.P.A. nursery school	Chicago W.P.A. nursery school
No. of children	16	19	17	17	16
Av. age (months)	29.6	42.7	39.1	39.1	41
Variability in age (sigmas)	4.3	4.8	7.8	6.4	5.2
Age range (months)	24-36	33-50	26-48	20-50	32-51
Sex	Boys 62% Girls 38%	Boys 68% Girls 32%	Boys 29% Girls 71%	Boys 53% Girls 47%	Boys 56% Girls 44%
Relative I.Q. status	Middle (112-136)	High (125-134)	Low (110)	Low (107)	Middle (114)
Toys and equipment (relative status)	Middle	High	Low	Low	Middle
Play Space	Limited (roof)	Large	Limited	Limited	Large
No. of teachers connected with the group	4	5	1 or 2	2	3
Proportion of conflicts interfered with by teachers	32.6%	36.2%	26.6%	32.5%	16.5%
National background: N. Europe Jewish S. Europe	 66% 34% 	 74% 26% 	 47% 53%	 100% 	 68.7% 31.3%
Av. education of fathers (no. of yrs.)				9.8	9.3
Av. education of mothers (no. of yrs.)				11.9	9.7
Av. no. of children in family				3.2	2.6
Av. birth order				2.6	2.3

We present below the results of analysis when the sub-populations are taken to consist of the four main nursery school groups in Table 2 (the Chicago group is omitted because the observations were incomplete).

In computing the inter-group and intra-group variance, it is customary to work simply with the numerators of the variance formulae, since they are the numbers which determine the percentage of contribution. These appear below as the total sum of squares, the sum of squares be-

tween means, and the sum of squares within groups. The first set of values below are obtained from the direct observations for the four groups.

	Group A	Group B	Group C	Bloomington
Mean	30.2	16.0	38.1	15.4
Sigma	8.5	8.0	9.1	8.2

Total sum of squares:	11,731
Sum of squares between means:	6,653
Sum of squares within groups:	5,078
Inter-group variance:	56.7%
Intra-group variance:	43.3%

In other words, more than half the total conflict variance is to be attributed to causal factors which differ from group to group.

An analysis of the variance of total conflict frequencies (direct plus indirect) gives similar results.

	Group A	Group B	Group C	Bloomington
Mean	62.1	34.3	80.7	30.8
Sigma	24.8	15.5	24.1	16.2

Total sum of squares:	57,867
Sum of squares between means:	29,126
Sum of squares within groups:	28,741
Inter-group variance:	50.3%
Intra-group variance:	49.7%

Addition of the indirect observations does not change the results significantly.

This means that sets of influences which vary from nursery-school population to nursery-school population are a much more important source of differences in conflict behavior than any of the general categories (age, sex, intelligence) discussed above, which cut across all the groups, within the age and intelligence limits of the present study. Instead of regarding this as unsatisfactory because it interferes with blanket generalizations about conflicts or other social behavior, and age, intelligence, etc., which would cover all children, this inter-group variance can be capitalized to give more concrete information about the formation of personality than ie possible with any treatment in terms of uniformly acting general concepts.

The exact figures for the inter-group and intra-group variances would undoubtedly fluctuate somewhat if the study were to be repeated on groups as similar as possible to these; it seems an adequate approximation to treat each variance as half the total. If about half the variance is attributable to differences between groups, and if this were interpreted in correlational terms, a correlation of around .70 would be indicated. Treatment of these results with the ordinary standard error procedures is not appropriate. These sub-populations are not random samples, but sorted and selected samples of the total population. It seems more promising to make the assumption that these values are relatively errorless, and to go on from there, than to combine diverse groups in an attempt to reduce the probable errors of the values. If future work shows this to be a fruitful procedure, all is well; if not, no great harm

has been done. Further work on more groups would result in a filling in of the total distribution of groups. Exactly what part of the total distribution of groups is represented here, it is impossible to say.

DISCUSSION OF RESULTS

The above analysis has given a division of the total variance of conflict behavior into a half that is due to differences in behavior within the groups and a half that is due to differences in behavior between groups. The primary value of this division is that it indicates where we should look to find the causes of difference in conflicts; to explain the inter-group differences, the important variables are those that vary from sub-population to sub-population, within and outside of the observational setting. It seems likely that at least half of the intra-group variance can be explained by reference to other variables in the behavior of the specific child, such as his number of social contacts, skill in getting along with other children, etc. Which of these would be dependent and which independent variables remains to be seen.

If we could explain why the upper and lower children in each group fell toward the ends of their distributions well enough to account for half the intra-group variance, again to draw an analogy with correlational procedure, the part of the variance accounted for would be equal to that obtained with a correlation of .87. We hope to gain further information on intra-group differences from work in progress on the interrelationship of different types of behavior.

A corollary of our analysis is the consideration of each child in relation to the mean of his own group, instead of in relation to a more general average. Thus the child who engaged in the most conflicts in the Bloomington group had a conflict frequency in direct observations which was not significantly above the general average of Jersild and Markey's three groups. She was considered a general behavior problem at the school, and would show considerable "maladjustment" by almost any criterion. It seems more meaningful to consider her as an extreme case in her own distribution than as near the average of all the children in all the groups. We have no way of telling what would happen to the conflict frequency of a child if he were changed from a high-conflict group to a low one, or vice versa, and given time to become readjusted. Shifts of this kind would enable us to estimate the influence of the group of children as a group on the conflict frequency of a particular child to an extent not possible at present.

The primary concern of the present paper is with the difference between groups. The causal factors here may first be divided into two groups 1) the various factors within the nursery school: the number and conduct of the teachers, the amount of play space, the number of toys, etc., 2) influences in the history of the individual children, particularly those outside the nursery school.

It is difficult to make an accurate assessment of the influence of individual differences in the conduct of teachers on the frequency of various kinds of behavior, but what information we have indicates that this is of minor importance. In the Bloomington school there were never more than two teachers present, and occasionally only one. In the

Jersild and Markey schools, there were four teachers in the A nursery school, five in the B school, and one or two in the C school. Obviously the number of teachers is not the decisive factor in the low frequency of conflicts in the Bloomington group. A value used by Jersild and Markey in estimating the influence of teachers is the per cent of conflicts in which the teachers interfered. Our discussion above indicated that this was not a decisive factor in these groups.

Concerning play space, the Bloomington group had less space per child than is available in most university nursery schools, and less than that in the Chicago school, so that here again the causes of difference in behavior must be sought elsewhere. This is not to say that none of these factors could ever be influential, but that their collective effect for the specific groups under discussion would account for only a small part of the inter-group variance.

This leads to a consideration of the influences in the extra-nursery-school history of the individual children. If we examine his behavior in enough detail, every child is, of course, unique, as is every other object of scientific examination. We have seen that the most likely general psychological divisions (age, sex, and intelligence) do not account for any appreciable part of the variance of conflict behavior in these particular populations. But we have also found that children who seem very "individual" when compared with their associates exhibit similarity when compared with other and quite different groups, so that some generality of treatment is possible. If we can find out why different groups give different values in different kinds of behavior we will have a part of the "individuality" of the individual child explained.

What the method used in this paper does, essentially, as opposed to the more commonly used correlational procedure, is to give an estimate of the amount of variance due to whole sets of causal influences, whether or not all the important factors are explicitly recognized. We cannot even be sure that we can list all the bases of selection which operated to form the particular sets of children discussed here. What we can say is that a whole set of factors, known and unknown, suspected and unsuspected, is responsible for the observed differences between sub-populations in conflict behavior. This outlines the problem.

An adequate treatment of the influences determining these differences in behavior would include all the things that are ordinarily treated in the psychology of personality. Instead of listing these, we will merely point to the families of the children involved, and express the opinion that these differences between groups are the result primarily of the differences, cultural and non-cultural, between the different groups of families and the complex circumstances in which they live. This merely indicates the locus of the problem, rather than supplying a set of answers.[3] Linton (17) offers an interesting hypothesis concerning the relative effect of cultural and non-cultural factors in interpersonal situations. "In general it seems that the closer and more continuous the relations between individuals, the greater the influence of those non-cultural factors relative to the social and cultural ones . . .The social contacts of the child are largely of this close, highly individualized

[3] *A careful discussion of "environmental" influences on the behavior of children is given by Arrington (2).*

sort, and the qualities of the people with whom he is associated are certainly of great importance in shaping his personality. Whether their effect is greater or less than that of the formal patterns of his society's culture is a question which we cannot at present answer" (17, p. 436). In dealing with specific persons it is often difficult or even impossible to say whether a given form of behavior is cultural or non-cultural in origin since cultural influences are mediated through specific persons, particularly through the parents, and so reach the child only in intermixture with the personal idiosyncracies of some specific person. A good description of the actual process of behavior formation is given by Anderson (1, pp. 850-851). "To the wide variety of situations to which he is exposed, the child reacts with a wide variety of responses. In his early years he tries out many techniques, such as whimpering, scolding, tantrums, smiling, giving in, wheedling, etc. Some result in unfavorable action on the part of others, some elicit favorable reactions. As a result, there is a continuous selection and sorting-over of responses, with selection of some and elimination of others. . .At first this process is unconscious and involuntary; later it may be quite deliberate and voluntary." Some actions which bring a desired response from a parent may be such as to bring a child into coincidence with cultural ways of behaving, as in the case of the earliest uses of language by a child, but others, for example, temper tantrums, may be reinforced by success although they are not in any way culturally prescribed, and although they may prove to be successful social techniques with only one other individual.

We have facing us an "inverse probability" problem, similar to that we should have if a person should say to us, "Last night in a bridge game, on the tenth hand, I made a small slam. What cards did I hold?" A child with one set of factors in his background may engage in the same number of conflicts as another with a quite different history. Our approach here partially overcomes the indeterminacy of the inverse probability problem of pointing to combinations of causal factors that give consistent differences between sub-populations of children. Although we cannot assess the weight of each separate variable in the combinations, we can estimate the weight of the combinations themselves. We can obtain information that would be lost if all the populations were combined and correlations computed, and we can predict the behavior of individual children in a way not possible with correlations computed for the whole population. If the same procedure were followed with other types of behavior, and for additional groups, we should be able to speak with more confidence about the influence of specific variables, as opposed to the influence of unanalyzed combinations of variables.

Specific hypotheses about individual variables may well wait until a wider variety of groups of children have been studied. It is quite possible that various causal factors may have significantly different weight in different populations; a particular form of behavior may occur with greater frequency with increase in intellectual level in one group, and show no such relation in another. That is, a causal factor which may have a strong influence in one group may show a zero weighting in another. This simply means that we will have to formulate increasingly complex theoretical structures to obtain predictability in this particular field.

The analysis of variance procedure used in the present paper represents one way in which this can be achieved in a systematic manner.

SUMMARY

The primary concern of this paper is the development of a procedure for dealing with differences in behavior in groups of preschool children from different settings. The results of our observations of the frequency of conflict behavior in two W.P.A. nursery school groups are combined with those of Jersild and Markey for three other nursery schools. An analysis of the variance of frequency of conflicts is made, which indicates that approximately half the total variance is due to inter-group factors and the other half to intra-group factors. Age, sex, intelligence, socio-economic group, and factors in the nursery school set-up failed to contribute significantly to the total variance in these groups. A need for more concrete descriptions of differences in social and family backgrounds than are now available is indicated as necessary for explanation of the inter-group behavior differences. Some of the implications of the analysis of variance technique as applied to individual differences in personality characteristics of preschool children are discussed.

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A TABLE OF THE DOUBLE INTEGRAL OF THE GAUSSIAN PROBABILITY FUNCTION[1]

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In the course of studies[2] on the eruption of the permanent teeth in children, it was found that a mathematical description of the age distribution of eruption of the separate morphological types of teeth could be obtained through the use of the normal probability (Gaussian) frequency function. In these investigations it was shown that the percentages of children at successive chronological ages who had a particular permanent tooth erupted into the mouth followed an S-shaped curve which could be fitted satisfactorily by the integral of the normal probability function. This finding leads to the observation that the area under the S-shaped curve (the double integral of the probability function) to any chronological age represents the total number of years of exposure of the tooth in the mouth per 100 children. The values of this area, which provide a measure of accumulated post-eruptive tooth age, have been found of considerable utility in studies on dental caries. The determination of post-eruptive tooth age values requires estimates of the double integral of the normal probability function ($\int_{-\infty}^{X}\int_{-\infty}^{X} e^{-X^2} dX$).

So far as the authors are aware, no tabled values of this double integral are available. Since it seems likely that these values may be useful in connection with other studies, it has seemed worth while to publish in full Table 1, which was prepared in connection with the studies on dental caries.

The arithmetic values of the double integral were derived by a finite difference method from values of the single integral given in Pearson's Tables.[3] The actual computations were carried out as follows: Values of the single integral for <u>even</u> one-one-hundredth values of the argument, X, were multiplied by .02 and added successively from X = -4.48 to X = + 4.48. This procedure gave values of the double integral at successive odd values of the argument from X = -4.49 to X = + 4.49. In a similar way values of the double integral were obtained for even values of the argument from X = -4.50 to X = + 4.50. In the calculations, the seven decimal place figures given in Pearson's tables were used, eight decimal places were carried after multiplication by .02, and the final double integral values obtained by successive addition were rounded to seven decimal places. The table has been carefully checked and is believed correct to six decimal places.

In this procedure the value of the double integral between $-\infty$ and X = -4.50 has been neglected. However, this does not decrease appreciably the values in the table since it is readily seen that the double integral converges very rapidly.[4]

[1]From the Division of Public Health Methods, National Institute of Health, Bethesda, Maryland

[2]See, Growth, Vol. I, p. 385 (1937), also Vol. II, p. 149 (1938).

[3]Pearson, K. Tables for Statisticians and Biometricians, Part I, Cambridge University Press. London (1924).

[4]The proof for this fact is similar to that used by Wintner in another connection. See, Wintner, Aurel, On the Asymptotic Formulae of Riemann and of LaPlace, Proc. Nat. Acad. of Sc. 20:57-62, (1934).

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In fact $\int_{-\infty}^{-|\varepsilon|} e^{-X^2} dX < \int_{-\infty}^{-|\varepsilon|} e^{-|X|} dX = \int_{-\infty}^{-|\varepsilon|} e^{X} dX = e^{X}\Big|_{-\infty}^{-|\varepsilon|} = e^{-|\varepsilon|}$

$$\therefore \int_{-\infty}^{-|\varepsilon|}\int_{-\infty}^{-|\varepsilon|} e^{-X^2} dX < \int_{-\infty}^{-|\varepsilon|} e^{X} dX = e^{-|\varepsilon|}$$

which can be made as small as desired.

It should be noted that it would be sufficient to present the values of the double integral only for negative values of the argument. The values of the double integral for positive X may be obtained by adding the arithmetic value of X to the value of the double integral at -X. This fact follows as a consequent of the symmetry of the curve $F(X) = \int e^{-X^2} dX$ with respect to (0, F (0)). In fact, from the accompanying figure it is seen that

$$\frac{1}{\sqrt{\pi}}\int_{-X_0}^{X_0}\int e^{-X^2} dX = X_0$$

For, from the symmetry of F (X)

$$A = A'$$

Also $B + A' = X_0$

Hence $\frac{1}{\sqrt{\pi}}\int_{-X_0}^{X_0}\int e^{-X^2} dX = B + A = X_0.$

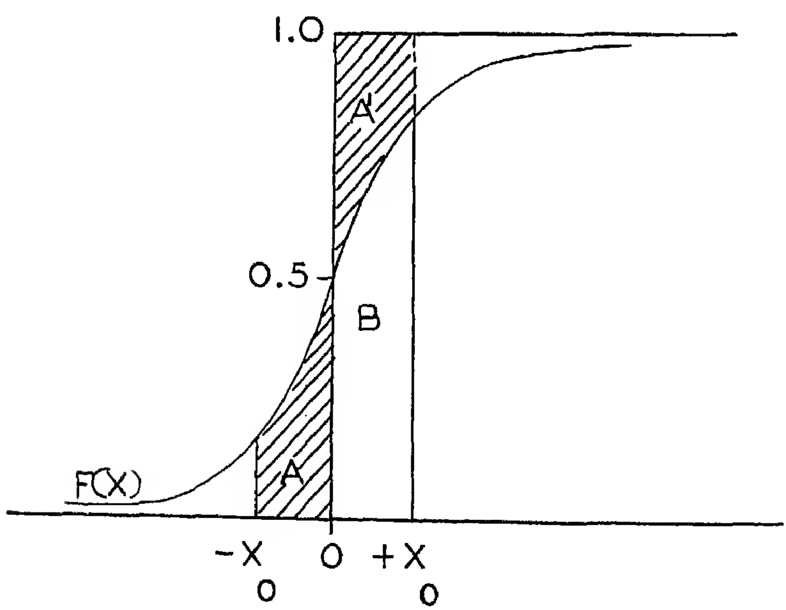


TABLE 1

X	Double Integral	X	Double Integral	X	Double Integral
- 4.50	.0000000	- 4.00	.0000065	- 3.50	.0000578
- 4.49	.0000000	- 3.99	.0000068	- 3.49	.0000601
- 4.48	.0000001	- 3.98	.0000071	- 3.48	.0000626
- 4.47	.0000001	- 3.97	.0000075	- 3.47	.0000652
- 4.46	.0000002	- 3.96	.0000079	- 3.46	.0000678
- 4.45	.0000002	- 3.95	.0000082	- 3.45	.0000706
- 4.44	.0000002	- 3.94	.0000086	- 3.44	.0000734
- 4.43	.0000003	- 3.93	.0000090	- 3.43	.0000764
- 4.42	.0000003	- 3.92	.0000095	- 3.42	.0000794
- 4.41	.0000004	- 3.91	.0000099	- 3.41	.0000826
- 4.40	.0000004	- 3.90	.0000104	- 3.40	.0000859
- 4.39	.0000005	- 3.89	.0000109	- 3.39	.0000894
- 4.38	.0000006	- 3.88	.0000114	- 3.38	.0000929
- 4.37	.0000006	- 3.87	.0000119	- 3.37	.0000966
- 4.36	.0000007	- 3.86	.0000125	- 3.36	.0001005
- 4.35	.0000008	- 3.85	.0000131	- 3.35	.0001004
- 4.34	.0000008	- 3.84	.0000137	- 3.34	.0001085
- 4.33	.0000009	- 3.83	.0000143	- 3.33	.0001128
- 4.32	.0000010	- 3.82	.0000150	- 3.32	.0001172
- 4.31	.0000011	- 3.81	.0000156	- 3.31	.0001218
- 4.30	.0000011	- 3.80	.0000163	- 3.30	.0001265
- 4.29	.0000012	- 3.79	.0000171	- 3.29	.0001315
- 4.28	.0000013	- 3.78	.0000178	- 3.28	.0001366
- 4.27	.0000014	- 3.77	.0000186	- 3.27	.0001419
- 4.26	.0000015	- 3.76	.0000195	- 3.26	.0001473
- 4.25	.0000016	- 3.75	.0000203	- 3.25	.0001530
- 4.24	.0000017	- 3.74	.0000212	- 3.24	.0001589
- 4.23	.0000018	- 3.73	.0000222	- 3.23	.0001649
- 4.22	.0000020	- 3.72	.0000232	- 3.22	.0001712
- 4.21	.0000021	- 3.71	.0000242	- 3.21	.0001778
- 4.20	.0000022	- 3.70	.0000252	- 3.20	.0001845
- 4.19	.0000023	- 3.69	.0000263	- 3.19	.0001915
- 4.18	.0000025	- 3.68	.0000275	- 3.18	.0001988
- 4.17	.0000026	- 3.67	.0000287	- 3.17	.0002062
- 4.16	.0000028	- 3.66	.0000299	- 3.16	.0002140
- 4.15	.0000029	- 3.65	.0000312	- 3.15	.0002220
- 4.14	.0000031	- 3.64	.0000325	- 3.14	.0002303
- 4.13	.0000033	- 3.63	.0000339	- 3.13	.0002389
- 4.12	.0000035	- 3.62	.0000354	- 3.12	.0002478
- 4.11	.0000037	- 3.61	.0000368	- 3.11	.0002570
- 4.10	.0000039	- 3.60	.0000384	- 3.10	.0002665
- 4.09	.0000041	- 3.59	.0000400	- 3.09	.0002763
- 4.08	.0000043	- 3.58	.0000417	- 3.08	.0002865
- 4.07	.0000045	- 3.57	.0000435	- 3.07	.0002970
- 4.06	.0000048	- 3.56	.0000453	- 3.06	.0003079
- 4.05	.0000050	- 3.55	.0000472	- 3.05	.0003192
- 4.04	.0000053	- 3.54	.0000491	- 3.04	.0003308
- 4.03	.0000056	- 3.53	.0000512	- 3.03	.0003428
- 4.02	.0000059	- 3.52	.0000533	- 3.02	.0003553
- 4.01	.0000061	- 3.51	.0000555	- 3.01	.0003681

TABLE 1 (Continued)

X	Double Integral	X	Double Integral	X	Double Integral
- 3.00	.0003814	- 2.50	.0020032	- 2.00	.0084891
- 2.99	.0003951	- 2.49	.0020661	- 1.99	.0087193
- 2.98	.0004093	- 2.48	.0021309	- 1.98	.0089560
- 2.97	.0004239	- 2.47	.0021975	- 1.97	.0091963
- 2.96	.0004391	- 2.46	.0022660	- 1.96	.0094434
- 2.95	.0004547	- 2.45	.0023365	- 1.95	.0096963
- 2.94	.0004709	- 2.44	.0024089	- 1.94	.0099552
- 2.93	.0004875	- 2.43	.0024833	- 1.93	.0102201
- 2.92	.0005048	- 2.42	.0025599	- 1.92	.0104912
- 2.91	.0005225	- 2.41	.0026386	- 1.91	.0107687
- 2.90	.0005409	- 2.40	.0027194	- 1.90	.0110526
- 2.89	.0005598	- 2.39	.0028025	- 1.89	.0113430
- 2.88	.0005794	- 2.38	.0028879	- 1.88	.0116401
- 2.87	.0005996	- 2.37	.0029756	- 1.87	.0119441
- 2.86	.0006206	- 2.36	.0030658	- 1.86	.0122550
- 2.85	.0006420	- 2.35	.0031583	- 1.85	.0125730
- 2.84	.0006642	- 2.34	.0032535	- 1.84	.0128981
- 2.83	.0006871	- 2.33	.0033512	- 1.83	.0132306
- 2.82	.0007107	- 2.32	.0034516	- 1.82	.0135706
- 2.81	.0007351	- 2.31	.0035546	- 1.81	.0139182
- 2.80	.0007603	- 2.30	.0036604	- 1.80	.0142736
- 2.79	.0007862	- 2.29	.0037691	- 1.79	.0146368
- 2.78	.0008130	- 2.28	.0038807	- 1.78	.0150081
- 2.77	.0008406	- 2.27	.0039952	- 1.77	.0153876
- 2.76	.0008690	- 2.26	.0041127	- 1.76	.0157754
- 2.75	.0008984	- 2.25	.0042334	- 1.75	.0161717
- 2.74	.0009286	- 2.24	.0043572	- 1.74	.0165766
- 2.73	.0009598	- 2.23	.0044843	- 1.73	.0169903
- 2.72	.0009920	- 2.22	.0046147	- 1.72	.0174129
- 2.71	.0010251	- 2.21	.0047485	- 1.71	.0178446
- 2.70	.0010593	- 2.20	.0048858	- 1.70	.0182855
- 2.69	.0010944	- 2.19	.0050265	- 1.69	.0187359
- 2.68	.0011307	- 2.18	.0051710	- 1.68	.0191958
- 2.67	.0011681	- 2.17	.0053191	- 1.67	.0196655
- 2.66	.0012066	- 2.16	.0054711	- 1.66	.0201450
- 2.65	.0012462	- 2.15	.0056268	- 1.65	.0206346
- 2.64	.0012871	- 2.14	.0057866	- 1.64	.0211345
- 2.63	.0013291	- 2.13	.0059504	- 1.63	.0216447
- 2.62	.0013724	- 2.12	.0061183	- 1.62	.0221655
- 2.61	.0014170	- 2.11	.0062904	- 1.61	.0221655
- 2.60	.0014630	- 2.10	.0064669	- 1.60	.0232395
- 2.59	.0015102	- 2.09	.0066477	- 1.59	.0237930
- 2.58	.0015590	- 2.08	.0068331	- 1.58	.0243578
- 2.57	.0016090	- 2.07	.0070230	- 1.57	.0249340
- 2.56	.0016607	- 2.06	.0072176	- 1.56	.0255220
- 2.55	.0017137	- 2.05	.0074170	- 1.55	.0261216
- 2.54	.0017684	- 2.04	.0076213	- 1.54	.0267334
- 2.53	.0018246	- 2.03	.0078305	- 1.53	.0273572
- 2.52	.0018824	- 2.02	.0080448	- 1.52	.0279936
- 2.51	.0019419	- 2.01	.0082643	- 1.51	.0286423

TABLE 1 (Continued)

X	Double Integral	X	Double Integral	X	Double Integral
- 1.50	.0293040	- 1.00	.0833108	- .50	.1977900
- 1.49	.0299785	- .99	.0849094	- .49	.2008930
- 1.48	.0306662	- .98	.0865325	- .48	.2040313
- 1.47	.0313672	- .97	.0881803	- .47	.2072053
- 1.46	.0320818	- .96	.0898530	- .46	.2104149
- 1.45	.0328101	- .95	.0915508	- .45	.2136604
- 1.44	.0335524	- .94	.0932741	- .44	.2169420
- 1.43	.0343088	- .93	.0950230	- .43	.2202598
- 1.42	.0350796	- .92	.0967978	- .42	.2236140
- 1.41	.0358649	- .91	.0985987	- .41	.2270046
- 1.40	.0366650	- .90	.1004260	- .40	.2304320
- 1.39	.0374800	- .89	.1022799	- .39	.2338962
- 1.38	.0383103	- .88	.1041607	- .38	.2373974
- 1.37	.0391559	- .87	.1060685	- .37	.2409357
- 1.36	.0400171	- .86	.1080037	- .36	.2445112
- 1.35	.0408942	- .85	.1099664	- .35	.2481241
- 1.34	.0417873	- .84	.1119569	- .34	.2517746
- 1.33	.0426966	- .83	.1139755	- .33	.2554627
- 1.32	.0436225	- .82	.1160223	- .32	.2591886
- 1.31	.0445650	- .81	.1180977	- .31	.2629524
- 1.30	.0455244	- .80	.1202017	- .30	.2667542
- 1.29	.0465010	- .79	.1223348	- .29	.2705942
- 1.28	.0474949	- .78	.1244970	- .28	.2744724
- 1.27	.0485064	- .77	.1266887	- .27	.2783889
- 1.26	.0495358	- .76	.1289100	- .26	.2823440
- 1.25	.0505831	- .75	.1311612	- .25	.2863376
- 1.24	.0516488	- .74	.1334426	- .24	.2903698
- 1.23	.0527329	- .73	.1357542	- .23	.2944409
- 1.22	.0538358	- .72	.1380965	- .22	.2985508
- 1.21	.0549575	- .71	.1404695	- .21	.3026996
- 1.20	.0560985	- .70	.1428735	- .20	.3068874
- 1.19	.0572589	- .69	.1453087	- .19	.3111144
- 1.18	.0584390	- .68	.1477754	- .18	.3153805
- 1.17	.0596389	- .67	.1502738	- .17	.3196859
- 1.16	.0608590	- .66	.1528040	- .16	.3240306
- 1.15	.0620994	- .65	.1553663	- .15	.3284147
- 1.14	.0633605	- .64	.1579609	- .14	.3328383
- 1.13	.0646423	- .63	.1605881	- .13	.3373013
- 1.12	.0659452	- .62	.1632479	- .12	.3418039
- 1.11	.0672694	- .61	.1659406	- .11	.3463462
- 1.10	.0686152	- .60	.1686665	- .10	.3509280
- 1.09	.0699828	- .59	.1714257	- .09	.3555496
- 1.08	.0713723	- .58	.1742184	- .08	.3602109
- 1.07	.0727842	- .57	.1770448	- .07	.3649120
- 1.06	.0742185	- .56	.1799052	- .06	.3696528
- 1.05	.0756756	- .55	.1827996	- .05	.3744336
- 1.04	.0771557	- .54	.1857284	- .04	.3792541
- 1.03	.0786590	- .53	.1886916	- .03	.3841146
- 1.02	.0801858	- .52	.1916895	- .02	.3890147
- 1.01	.0817363	- .51	.1947222	- .01	.3939549

TABLE 1 (Continued)

X	Double Integral	X	Double Integral	X	Double Integral
.00	.3989349	+ .51	.7047222	+1.01	1.0917363
+ .01	.4039549	+ .52	.7116895	+1.02	1.1001858
+ .02	.4090147	+ .53	.7186916	+1.03	1.1086590
+ .03	.4141145	+ .54	.7257284	+1.04	1.1171557
+ .04	.4192541	+ .55	.7327996	+1.05	1.1256756
+ .05	.4244335				
+ .06	.4296528	+ .56	.7399052	+1.06	1.1342185
+ .07	.4349120	+ .57	.7470448	+1.07	1.1427842
+ .08	.4402109	+ .58	.7542184	+1.08	1.1513723
+ .09	.4455496	+ .59	.7614257	+1.09	1.1599828
+ .10	.4509280	+ .60	.7686665	+1.10	1.1686152
+ .11	.4563462	+ .61	.7759406	+1.11	1.1772694
+ .12	.4618039	+ .62	.7832479	+1.12	1.1859452
+ .13	.4673013	+ .63	.7905881	+1.13	1.1946423
+ .14	.4728383	+ .64	.7979609	+1.14	1.2033605
+ .15	.4784147	+ .65	.8053663	+1.15	1.2120994
+ .16	.4840306	+ .66	.8128040	+1.16	1.2208590
+ .17	.4896859	+ .67	.8202738	+1.17	1.2296389
+ .18	.4953805	+ .68	.8277754	+1.18	1.2384390
+ .19	.5011144	+ .69	.8353087	+1.19	1.2472589
+ .20	.5068874	+ .70	.8428735	+1.20	1.2560985
+ .21	.5126996	+ .71	.8504695	+1.21	1.2649575
+ .22	.5185508	+ .72	.8580965	+1.22	1.2738358
+ .23	.5244409	+ .73	.8657542	+1.23	1.2827329
+ .24	.5303698	+ .74	.8734426	+1.24	1.2916488
+ .25	.5363376	+ .75	.8811612	+1.25	1.3005831
+ .26	.5423440	+ .76	.8889100	+1.26	1.3095358
+ .27	.5483889	+ .77	.8966887	+1.27	1.3185064
+ .28	.5544724	+ .78	.9044970	+1.28	1.3274949
+ .29	.5605942	+ .79	.9123348	+1.29	1.3365010
+ .30	.5667542	+ .80	.9202017	+1.30	1.3455244
+ .31	.5729524	+ .81	.9280977	+1.31	1.3545650
+ .32	.5791886	+ .82	.9360223	+1.32	1.3636225
+ .33	.5854627	+ .83	.9439755	+1.33	1.3726966
+ .34	.5917746	+ .84	.9519569	+1.34	1.3817873
+ .35	.5981241	+ .85	.9599664	+1.35	1.3908942
+ .36	.6045112	+ .86	.9680037	+1.36	1.4000171
+ .37	.6109357	+ .87	.9760685	+1.37	1.4091559
+ .38	.6173974	+ .88	.9841607	+1.38	1.4183103
+ .39	.6238962	+ .89	.9922799	+1.39	1.4274800
+ .40	.6304320	+ .90	1.0004260	+1.40	1.4366650
+ .41	.6370046	+ .91	1.0085987	+1.41	1.4458649
+ .42	.6436140	+ .92	1.0167978	+1.42	1.4550796
+ .43	.6502598	+ .93	1.0250230	+1.43	1.4643088
+ .44	.6569420	+ .94	1.0332741	+1.44	1.4735524
+ .45	.6636604	+ .95	1.0415508	+1.45	1.4828101
+ .46	.6704149	+ .96	1.0498530	+1.46	1.4920818
+ .47	.6772053	+ .97	1.0581803	+1.47	1.5013672
+ .48	.6840313	+ .98	1.0665325	+1.48	1.5106662
+ .49	.6908930	+ .99	1.0749094	+1.49	1.5199785
+ .50	.6977900	+1.00	1.0833108	+1.50	1.5293040

TABLE 1 (Continued)

X	Double Integral	X	Double Integral	X	Double Integral
+1.51	1.5386423	+2.01	2.0182643	+2.51	2.5119419
+1.52	1.5479936	+2.02	2.0280448	+2.52	2.5218824
+1.53	1.5573572	+2.03	2.0378306	+2.53	2.5318246
+1.54	1.5667334	+2.04	2.0476213	+2.54	2.5417684
+1.55	1.5761216	+2.05	2.0574170	+2.55	2.5517137
+1.56	1.5855220	+2.06	2.0672176	+2.56	2.5616507
+1.57	1.5949340	+2.07	2.0770230	+2.57	2.5716090
+1.58	1.6043578	+2.08	2.0868331	+2.58	2.5815590
+1.59	1.6137930	+2.09	2.0966477	+2.59	2.5915102
+1.60	1.6232395	+2.10	2.1064669	+2.60	2.6014630
+1.61	1.6326970	+2.11	2.1162904	+2.61	2.6114170
+1.62	1.6421655	+2.12	2.1261183	+2.62	2.6213724
+1.63	1.6516447	+2.13	2.1359504	+2.63	2.6313291
+1.64	1.6611345	+2.14	2.1457866	+2.64	2.6412871
+1.65	1.6706346	+2.15	2.1556268	+2.65	2.6512462
+1.66	1.6801450	+2.16	2.1654711	+2.66	2.6612066
+1.67	1.6896655	+2.17	2.1753191	+2.67	2.6711681
+1.68	1.6991958	+2.18	2.1851710	+2.68	2.6811307
+1.69	1.7087359	+2.19	2.1950266	+2.69	2.6910944
+1.70	1.7182855	+2.20	2.2048858	+2.70	2.7010593
+1.71	1.7278445	+2.21	2.2147485	+2.71	2.7110251
+1.72	1.7374129	+2.22	2.2246147	+2.72	2.7209920
+1.73	1.7469903	+2.23	2.2344843	+2.73	2.7309598
+1.74	1.7565766	+2.24	2.2443572	+2.74	2.7409285
+1.75	1.7661717	+2.25	2.2542334	+2.75	2.7508984
+1.76	1.7757754	+2.26	2.2641127	+2.76	2.7608690
+1.77	1.7853875	+2.27	2.2739952	+2.77	2.7708406
+1.78	1.7950081	+2.28	2.2838807	+2.78	2.7808130
+1.79	1.8046368	+2.29	2.2937691	+2.79	2.7907862
+1.80	1.8142735	+2.30	2.3036604	+2.80	2.8007603
+1.81	1.8239182	+2.31	2.3135546	+2.81	2.8107351
+1.82	1.8335706	+2.32	2.3234516	+2.82	2.8207107
+1.83	1.8432306	+2.33	2.3333512	+2.83	2.8306871
+1.84	1.8528981	+2.34	2.3432535	+2.84	2.8406642
+1.85	1.8625730	+2.35	2.3531583	+2.85	2.8506420
+1.86	1.8722550	+2.36	2.3630658	+2.86	2.8606205
+1.87	1.8819441	+2.37	2.3729756	+2.87	2.8705996
+1.88	1.8916401	+2.38	2.3828879	+2.88	2.8805794
+1.89	1.9013430	+2.39	2.3928025	+2.89	2.8905598
+1.90	1.9110526	+2.40	2.4027194	+2.90	2.9005409
+1.91	1.9207687	+2.41	2.4126385	+2.91	2.9105225
+1.92	1.9304912	+2.42	2.4225599	+2.92	2.9205048
+1.93	1.9402201	+2.43	2.4324833	+2.93	2.9304875
+1.94	1.9499552	+2.44	2.4424089	+2.94	2.9404709
+1.95	1.9596963	+2.45	2.4523365	+2.95	2.9504547
+1.96	1.9694434	+2.46	2.4622660	+2.96	2.9604391
+1.97	1.9791963	+2.47	2.4721975	+2.97	2.9704239
+1.98	1.9889550	+2.48	2.4821309	+2.98	2.9804093
+1.99	1.9987193	+2.49	2.4920651	+2.99	2.9903951
+2.00	2.0084891	+2.50	2.5020032	+3.00	3.0003814

TABLE 1 (Concluded)

X	Double Integral	X	Double Integral	X	Double Integral
+ 3.01	3.0103681	+ 3.61	3.5100555	+ 4.01	4.0100061
+ 3.02	3.0203553	+ 3.62	3.5200533	+ 4.02	4.0200059
+ 3.03	3.0303428	+ 3.53	3.5300512	+ 4.03	4.0300056
+ 3.04	3.0403308	+ 3.54	3.5400491	+ 4.04	4.0400053
+ 3.06	3.0503192	+ 3.55	3.6500472	+ 4.05	4.0500060
+ 3.06	3.0603079	+ 3.56	3.5600453	+ 4.06	4.0600048
+ 3.07	3.0702970	+ 3.57	3.5700435	+ 4.07	4.0700045
+ 3.08	3.0802865	+ 3.58	3.5800417	+ 4.08	4.0800043
+ 3.09	3.0902763	+ 3.59	3.5900400	+ 4.09	4.0900041
+ 3.10	3.1002665	+ 3.60	3.6000384	+ 4.10	4.1000039
+ 3.11	3.1102570	+ 3.61	3.6100368	+ 4.11	4.1100037
+ 3.12	3.1202478	+ 3.62	3.6200354	+ 4.12	4.1200035
+ 3.13	3.1302389	+ 3.63	3.6300339	+ 4.13	4.1300033
+ 3.14	3.1402303	+ 3.64	3.6400325	+ 4.14	4.1400031
+ 3.15	3.1502220	+ 3.65	3.6600312	+ 4.15	4.1500029
+ 3.16	3.1602140	+ 3.66	3.6600299	+ 4.16	4.1600028
+ 3.17	3.1702062	+ 3.67	3.6700287	+ 4.17	4.1700026
+ 3.18	3.1801988	+ 3.68	3.6800276	+ 4.18	4.1800025
+ 3.19	3.1901916	+ 3.69	3.6900263	+ 4.19	4.1900023
+ 3.20	3.2001846	+ 3.70	3.7000252	+ 4.20	4.2000022
+ 3.21	3.2101778	+ 3.71	3.7100242	+ 4.21	4.2100021
+ 3.22	3.2201712	+ 3.72	3.7200232	+ 4.22	4.2200020
+ 3.23	3.2301649	+ 3.73	3.7300222	+ 4.23	4.2300018
+ 3.24	3.2401589	+ 3.74	3.7400212	+ 4.24	4.2400017
+ 3.26	3.2501630	+ 3.76	3.7600203	+ 4.26	4.2500016
+ 3.26	3.2601473	+ 3.76	3.7600195	+ 4.26	4.2600015
+ 3.27	3.2701419	+ 3.77	3.7700186	+ 4.27	4.2700014
+ 3.28	3.2801366	+ 3.78	3.7800178	+ 4.28	4.2800013
+ 3.29	3.2901315	+ 3.79	3.7900171	+ 4.29	4.2900012
+ 3.30	3.3001265	+ 3.80	3.8000163	+ 4.30	4.3000011
+ 3.31	3.3101218	+ 3.81	3.8100156	+ 4.31	4.3100011
+ 3.32	3.3201172	+ 3.82	3.8200150	+ 4.32	4.3200010
+ 3.33	3.3301128	+ 3.83	3.8300143	+ 4.33	4.3300009
+ 3.34	3.3401085	+ 3.84	3.8400137	+ 4.34	4.3400008
+ 3.35	3.3501044	+ 3.85	3.8500131	+ 4.35	4.3500008
+ 3.36	3.3601005	+ 3.86	3.8600126	+ 4.36	4.3600007
+ 3.37	3.3700966	+ 3.87	3.8700119	+ 4.37	4.3700006
+ 3.38	3.3800929	+ 3.88	3.8800114	+ 4.38	4.3800006
+ 3.39	3.3900894	+ 3.89	3.8900109	+ 4.39	4.3900005
+ 3.40	3.4000859	+ 3.90	3.9000104	+ 4.40	4.4000004
+ 3.41	3.4100826	+ 3.91	3.9100099	+ 4.41	4.4100004
+ 3.42	3.4200794	+ 3.92	3.9200095	+ 4.42	4.4200003
+ 3.43	3.4300764	+ 3.93	3.9300090	+ 4.43	4.4300003
+ 3.44	3.4400734	+ 3.94	3.9400086	+ 4.44	4.4400002
+ 3.45	3.4500706	+ 3.95	3.9500082	+ 4.45	4.4500002
+ 3.46	3.4600678	+ 3.96	3.9600079	+ 4.46	4.4600002
+ 3.47	3.4700652	+ 3.97	3.9700076	+ 4.47	4.4700001
+ 3.48	3.4800626	+ 3.98	3.9800071	+ 4.48	4.4800001
+ 3.49	3.4900601	+ 3.99	3.9900068	+ 4.49	4.4900000
+ 3.50	3.5000578	+ 4.00	4.0000065	+ 4.60	4.5000000

A NEW TAPPING TEST

BLAKE CRIDER[1]

The psychologist has an occasional need for a tapping test which is simple, compact, inexpensive, and at the same time is fairly reliable. It is believed we have such a test.

A Veeder counter (Stoelting No. 22403) was mounted in a heavy metal base although it can just as well be clamped to a heavy table. The handle of the counter projected upward on top of which was soldered a penny. A slight pressure on the projecting handle registers a number on the dial which is turned toward the examiner.

The examiner demonstrates the procedure for taking the test in this manner: "Take your first two fingers and extend them straight out, like this. Keep your other two fingers folded back under your thumb. When I say 'go' start tapping as fast as you can and keep on tapping until I say 'stop'!" A few taps were then made rapidly on the counter in order to demonstrate further the hand position and the procedure for tapping.

The subject was permitted to tap three seconds with the generally preferred hand, and three seconds with the other hand. This not only gave a preliminary practice with each hand but also permitted the examiner to correct any misunderstanding on the part of the subject. In these preliminary trials it was also pointed out to the subject that he was not to rest his arm on the table but was to let it swing free from the elbow.

The actual testing consisted of tapping with the preferred hand first for six seconds, the preferred hand being considered the writing or throwing hand. The score was taken from the counter and another six seconds interval followed with the other hand. This gave an interval of rest of approximately five seconds between each tapping series. This sequence was repeated until each hand tapped three, six second intervals, giving a total of 18 seconds tapping time with each hand. A split-second stop watch was used to record the time.

Preferential handedness scores were obtained by dividing the total score obtained in three series of six seconds each on one hand by the total score from three series made with the other hand, the left hand scores being used as the divisor. Each quotient was multiplied by 100. This method gave a series of scores ranging from 55 to 197. A score of 55 represents the most extreme case of left hand facility on the tapping device while a score of 179 represents the most extreme case of right hand facility.

The reliability of the tapping test was determined by correlating the scores on the first series of three tests with the second series, the first with the third, and the second with the third. This gave three correlations of .64, .65, and .67. Since the total test is three times as long as any one series the Spearman-Brown formula was applied with coefficient of reliability of .84.

The mean tapping scores on 707 subjects are recorded in the following table.

[1] *From Cleveland, Ohio*

MEAN TAPPING SCORES

Age	Mean	S.D.	P.E.m	N
5	114.02	21.5	1.69	74
6	114.63	15.0	1.01	101
7	116.20	16.0	1.04	107
8	113.57	12.0	.84	92
9	117.40	14.5	.88	99
10	119.30	18.5	1.27	100
11	120.32	17.5	1.02	134

THE NATURE AND CHARACTER OF PRE-ADOLESCENT GROWTH IN READING ACHIEVEMENT

CECIL V. MILLARD[1]

CONTENTS

INTRODUCTION

The point of view which considers the skill subjects as tools to be used in an experiential setting is rapidly gaining widespread approval. Some recent courses of study go so far as to treat the acquisition of ekill in the three "R's" as an incidental activity within a program based on the purposeful life activities of the child. Even in those schoole where administrative regulations hold to the old regime, emphasis upon achievement has been greatly diminished. One must admit, regardlees of whether he approves or disapproves, that education in terms of child growth rather than in terms of subject matter achievement is becoming a more and more popular concept. Many teachers now appraise their programs according to the contribution made to the social, emotional, and physical, ae well as that made to the intellectual development of the child. Activities in reading and in other subjects, in the new program, become activities for the purpose of facilitating child growth.

Many conventional teachers, most parents, and perhaps even some teachere of the modern school of thought ask, "Does this mean, then, that achievement is being neglected?" The question is generally answered in the affirmative. Except in rare instances in which an attempt has been made to show that achievement is greater when subject matter units are introduced in situations only where there is need for their acquisition, the general view assumes that subject matter achievement is of secondary importance to the growth of the "whole" child.

The emphasis upon child development, in the new curriculum, indicates the need for successive measures of growth. Dissatisfaction has arisen with the conventional procedure of measuring at a given time all available

[1] *From the Department of Education, Michigan State College, East Lansing, Michigan.*

The writer is greatly indebted to the staff of teachers and the Board of Education of the Henry Ford School, Dearborn, Michigan, for making this study possible.

Further indebtedness is acknowledged to Dr. Stuart A. Courtis, of the University of Michigan, for helpful criticism and advice. For encouragement and assistance in preparing the manuscript the writer is indebted to Dr. Victor H. Noll, of Michigan State College.

subjects, classifying measurements into age groups, and computing mean values for each level. Investigators are now beginning to question the validity of the approach which assumes that the individuals in each age group are representative of what the individuals in preceding age groups will become in time. Although experimentalists, teachers, and administrators realize that grouped scores ignore the important factor of selection, massed statistics, norms and standards have developed a far reaching appeal. There exists today, then, an increasing need for studies based on successive measures of individual children. Successive measures enable the investigator to follow the child through various stages of growth and appear to offer valid data for an approach to the study of the development of the whole child.

A recognition of the need for this type of investigation is shown in the Harvard Growth Studies, the Iowa Studies, and in some private agencies for child study. Very little has been done, however, by those who have had the greatest responsibility in determining the type of environment surrounding the child, namely, the curriculum makers. Too few in this group have ever observed a complete cycle of development in, for example, a child's learning curve in reading.

What are the factors conditioning the learning curve in reading? What change results in the curve as the child progresses from one grade to another? What relation does intelligence have upon reading performance? The approach of this study involves a further consideration of certain of these problems.

General Plan

The investigation has three purposes: 1) to determine individual differences in the development of reading achievement in children; 2) to discover the general pattern of growth of pre-adolescent reading; 3) to measure the effect of certain factors which affect reading development.

The period of measurement extends over a six year interval. Children included in the study range from those now in the fourth grade to those now in the tenth grade. All data used, however, were limited to those found within the pre-adolescent cycle of development.[2] Children used as cases were those for whom measurements covering at least a three year span were available.

General Setting

Children attending the Henry Ford School, Dearborn, were utilized as subjects. Due to such reasons as absence, moving away, entering school in the middle grades, etc., the cases selected do not all have the same number of measures. No valid criticism can be made of this condition since the entire investigation is based upon a study of individual development.

The children in this school are, in general, typical of the higher level of social status found in an industrial community. Very few of the

[2] *A study concerned with adolescent effects will appear at a later date. Two criteria were used for the selection of data for each case. First, no data were included which overlapped the period marking the onset of puberty. Secondly, no data were included which alone appeared to indicate a well-defined second cycle of reading growth.*

cases represent social extremes.

The stringent criterion set up for the selection of cases - three years of consecutive measures preceding adolescence - naturally reduces the number of cases available. Although the number studied represents a comparatively small group, the one hundred and more children included should be regarded as one hundred and more case studies portraying a typical pattern of pre-adolescent growth in reading.

PROBLEMS INVOLVED IN THE ANALYSES

Units of Measurement

Ever since Wissler[3] used the newly developed Pearsonian technique, there has been an increasing use of the correlational method in determining relationships between various aspects of growth. By correlational procedures, relationships have been established between such aspects of growth as height and weight,[4] physical measures and mental measures, mental measures and achievement, and many other phases of human growth. Where single measures of groups of individuals were available, it has proven to be very adaptable, and many noteworthy applications have been made in the study of educational problems.

Successive measures on individual children present further possibilities for educational research. In the biological sciences, where cumulative data can easily be obtained, several methods for a mathematical expression of growth have been devised. In the main, most of these have their derivation in either of two types of curves called the logarithmic and the logistic. The main difference between the two is found in the location of their respective inflection points. In the logistic curve, the point of inflection lies halfway between the two points taken as the beginning and the end of growth. In the logarithmic curve, the inflection point is located nearer the beginning than the end.[5] In the logistic curve, the point lying to the right of the inflection point is the exact reversal of the half lying to the left. This characteristic implies that the forces acting during the second half of the cycle are equal in magnitude to the forces operating during the first half, and are similarly distributed in time. The logarithmic curve does not exhibit this symmetry.[6-7]

Both types of curves have been widely used in the biological fields. The honor for the introduction of a growth technique in educational research belongs to Courtis.[8] Courtis has isolated and identified factors which are essential elements of the growth process. By defining factors, he has been able to determine by scientific experimentation the laws which express the relation of these factors to growth.

[3] *Wissler, Clark. "The corrleation of mental and physical tests," Monograph Supplements, III, No. 6. Princeton, New Jersey: Psychological Review Co., 1901. Pp. 62.*

[4] *Baldwin, Bird T. The physical growth of children from birth to maturity. Iowa City, Iowa: University of Iowa Studies in Child Welfare, No. 1, 1921. Pp. 411.*

[5] *In the standard curve, the inflection point is found at the point in the curve equal to $\frac{1}{e}$.*

[6] *Pearl, Raymond, and Reed, Lowell J., "Skew-growth curves," Proceedings of the National Academy of Sciences, XI, January, 1925, 16-22.*

[7] *Winsor, Charles P., "A comparison of certain symmetrical growth curves," Journal of the Washington Academy of Sciences, XXII, February, 1932, 73-76.*

[8] *Courtis, S. A., "The measurement of growth." Ann Arbor, Michigan: Brumfield and Brumfield, 1932. Pp. 155 + 62.*

The claims of the Courtis technique over other mathematical expressions of growth may be summarized as follows:[9]

(1) The meaning of the various constants has been scientifically determined;

(2) Fundamental laws or generalizations have been embodied in a simple manner within an analytic expression or rational equation;

(3) A natural unit has been employed which is constant at all points of the scale of measurement, under the conditions of the assumptions underlying its development.

In utilizing the growth technique, a unity of measurement which affords a convenient basis of comparison of developments is "time". Common observation indicates that differences exist in the "times" of different growths to achieve maturity. An oak tree has a longer maturation period than a flower. Educators are familiar with the differences among children in the "time" required to reach a given mental development. For example, it takes the "dull" child a much longer period of time than a "normal" child to reach a mental development of ten years.

In educational diagnostic procedures, the I.Q. is generally utilized as a ratio characterizing the amount of mental growth achieved at a given time. There is no reason, however, why the I.Q. should not be determined by ratios between the "times" necessary to reach a given mental development. The advantage of the conventional I.Q. lies in the convenience with which it can be obtained by a single intelligence testing. Its disadvantage is found in its variability.[10] For example, in cases 24F and 42F (Figure 1), the ratios between the mental ages of the two children range from 1.71 to 1.23 over a period of forty months. This variation, as well as the variation in the I.Q.'s themselves, from 110 to 132 for case 24F and from 73 to 91 for case 42F, results from differences in ages at which mental growth begins, from differences in the maximum amount of growth to be achieved, and from differences in ratios of growth. In determining the I.Q., in the conventional manner, none of these characteristics of individual growth are given proper consideration. In general, the I.Q. represents a measure of the effect of a combination of factors without due regard being given to their specific effect upon growth.

It may not be known generally that in a given test of, for example, 100 items, not all children will approach the same maximum. It is usually assumed that all children eventually will be able to respond correctly to each test item. This is not the case. If measurement of a given child is continued periodically year after year, observation of the resulting curve will show a rounding off of the curve at a definite point, perhaps at a score of 80. Another child's scores may be found to round off at an entirely different point, possibly twenty points or more lower. Thus equal scores at a given time for these two children, although of the same magnitude at one time, have entirely different mean-

[9] *Millard, C. V., Factors conditioning performance in spelling. Ann Arbor, Mich.: University of Michigan Research Monographs, 1937. Pp. XI + 207.*

[10] *The second monograph in this series will portray the character of mental development in a large number of individual children.*

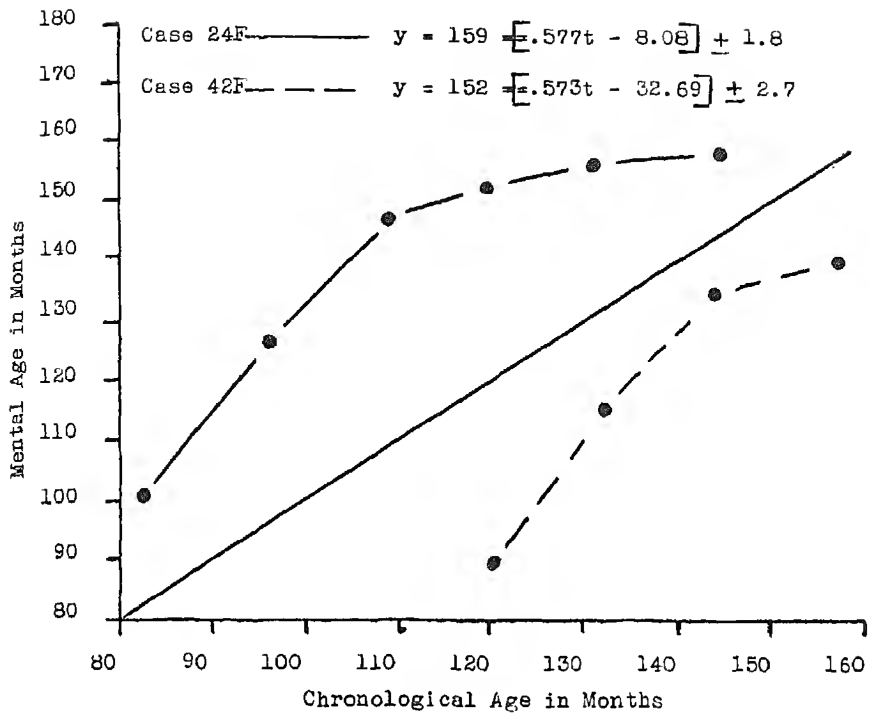


Fig. 1. Comparison of Mental Developments of Two Girls with widely varying I.Q.'s.

Observed I. Q.'s

24F	42F
132	73
137	87
134	91
126	90
110	

Ratios between Mental Ages Computed from Equations:

Age	Mental Age 24F	Mental Age 42F	Ratios
120	152.0	88.5	1.71
130	154.5	110.0	1.40
140	157.0	127	1.23

Ratios between rates: 1.007

Note: These two widely differing children are growing at approximately equal rates.

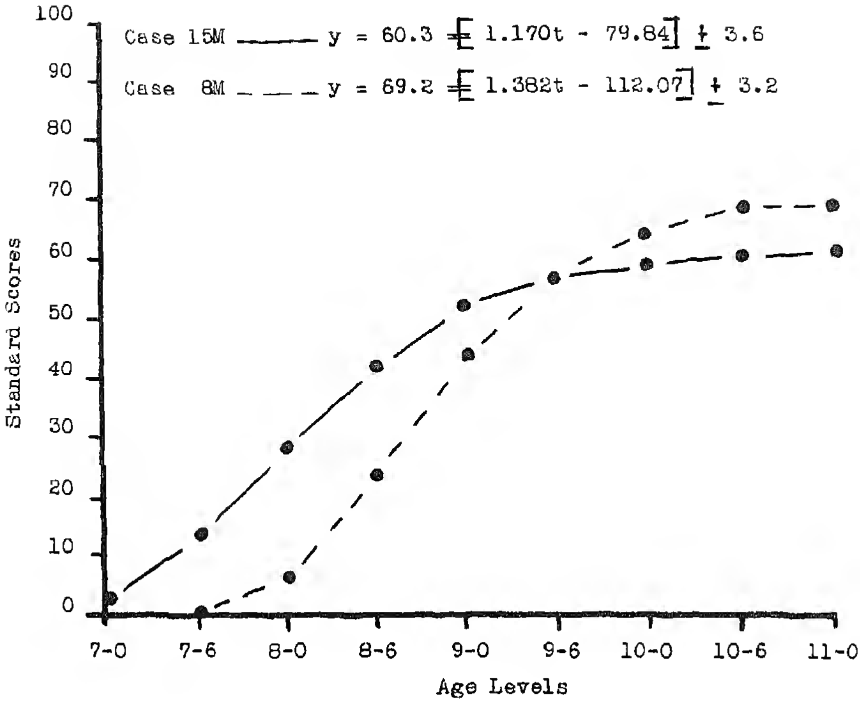


Fig. 2. Comparison of Reading Curves of Two Boys of Equal I.Q. (Showing the Fallacy in Matching Pupils on the Basis of Equal Performances at Any One Given Time).

Difference in Status (Stanford Scores)
(Constantly Varies)
Which is the Superior Child?

Age	15M	8M	Difference
90	12.4	.2	+ 12.19
96	27.6	5.4	+ 22.2
102	40.9	22.7	+ 18.2
108	49.8	42.3	+ 7.5
114	55.0	55.0	0.0
120	57.5	63.2	- 5.7
126	58.9	66.5	- 7.6
132	59.6	68.0	- 8.4

Ratio Between Rates: 1.170 divided by 1.382, or .836
Note: 8M is superior in rate of growth.

ings when considered in terms of the maxima toward which the children are growing (Figure 2). In the conventional procedure, equal scores at a given time would be regarded as equivalent achievements. The differences in achievement which would be noted on a later testing might be attributed to the effect of some other factor, for example, teaching. As a matter of fact, in the examples shown in Figure 2, the differences in scores found at the later dates are the result of factors which were in operation throughout the entire growth cycle. Thus it would not be difficult to show that great injustice is done many children by comparing their scores, or measurements with measures of central tendencies which do not take into account the various factors in the developmental process which the scores represent.

In the growth technique, magnitude scores are used in analysis only as they are expressed as percentages of the maximum achieved at maturity.[11]

The Unit of Measurement A Measure of Quality

As has already been indicated, differences between individuals express themselves in three ways in growth, other things being equal: 1) in differences in development at the beginning of a growth cycle. This characteristic of growth is called incipiency and in the equation may be utilized in determining at what age the growth in a given cycle begins; 2) in differences in the maximum attained at maturity of a given cycle; and 3) in differences in the rate of growth.

When different children, or different groups of children, have the same development at the beginning of a cycle (incipiency), and are growing toward the same maximum, differences in quality may be ascertained by a comparison of rates of growth. Since the growth equation states exactly the amount of isochronic growth achieved in a given time unit, the "quality" relationship may be determined mathematically from the equation,

$$\frac{q_1}{q_2} = \frac{r_1}{r_2}$$

Quality then becomes similar to what is commonly called intelligence or brightness. However, under the conditions governing the use of the growth treatment, quality differs from the I.Q. in that it is constant at every point of growth within a given cycle.

In the procedure followed throughout this study, the effect of factors was determined by comparing differences in time consumed to reach a given maturity. In this connection the term "Developmental Ratio" is used.[12] In computing the developmental ratio, it is not necessary to compare the total lengths of the period of maturation. Comparison of the "times required to achieve equal developments" will yield the same result. Expressed mathematically (other things being equal), Developmental Ratio (D. R.), is inversely proportional to the "times", T, required for equal development. Or

[11] *See Courtis, S. A., ibid; pp. 108-119, for computation of maxima.*

[12] *Proposed by Courtis, S. A., The measurement of growth. Ann Arbor, Brumfield and Brumfield.*

$$\frac{\text{D. R. (Individual)}}{\text{D. R. (Group)}} = \frac{\text{T (Group)}}{T_2 \text{ (Individual)}}$$

Procedure Followed

Courtis has shown that all growth follows a standard pattern of development. Does this mean, then, that growth in height, growth in mental development, and growth in achievement follow comparable patterns? Can various aspects of growth in one type of development be predicted from aspects of growth in an entirely unrelated type of development? Can relationships comparable to an I.Q. be determined from a knowledge of a child's growth in reading, or from a knowledge of the character of his growth in height?

It is the purpose of this study to compute growth equations in reading for all available cases, and to study the relationship of the individual D. R. to the individual maxima achieved.[13] Other problems involve a prediction from the reading scores of a relationship comparable to the I.Q., as well as to point out techniques for the measurement of the effect of factors which influence growth in reading achievement.

In a problem of this kind, the method of procedure is to advance from the known to the unknown. Although the I.Q. represents in many respects an unreliable relationship, it is at present our best known and most widely used index of mental development. Therefore, certain of the procedures followed will involve the computation of "indices" of reading achievement which may be compared with individual I.Q.'s.

MEASUREMENT OF READING ACHIEVEMENT

Treatment of Data

Data used for analyses consisted of Stanford reading scores for fifty-five boys and for sixty-two girls. For this group of one hundred seventeen children, five hundred seventy-six reading scores were available. All children were in attendance in the Henry Ford School for at least three years, and all scores were taken at the pre-adolescent level.[14]

Plan of Procedure

The following plan was used in consolidating individual data:

Step 1. An equation for the growth of each individual was derived from the actual measurements (Appendices A and B).

Step 2. These equations were solved for values for each individual at the ages at which the tests were given.

Step 3. Comparisons were then made between the computed values and the actual values obtained on the tests.

[13] *Scores used represent the average interpolated score of paragraph meaning and word meaning, as indicated by Stanford scoring instructions.*

[14] *See definition on page 72.*

Adequacy of the Equations in Describing Growth in Reading

Many people will find it hard to believe that it is possible to describe a child's growth in reading in exact mathematical terms. The equations derived, however, picture the entire reading development through approximate third, fourth, and fifth grade levels within a mean deviation of less than ± 3.0 points from the actual measured performances. Human behavior is usually viewed as erratically variable; but among the one hundred eighteen children available for case analysis, only two showed enough variation in reading performance to complicate the computation of a reasonably accurate performance.

The answer to the question as to the adequacy of the growth technique in describing reading performance is found in a study of the deviations of predicted performance from observed performance (Figure 3).[15] The total number of predictions made was 576. Approximately one-third of the errors were found to be less than ± 1.0 from the actual measures. In view of the conditions which tend to produce unreliable test results, such as unreliability in the test itself, the varying effects of teaching as the child goes from grade to grade, variation in health, etc., it seems remarkable that individual performances follow such a regular pattern of development.

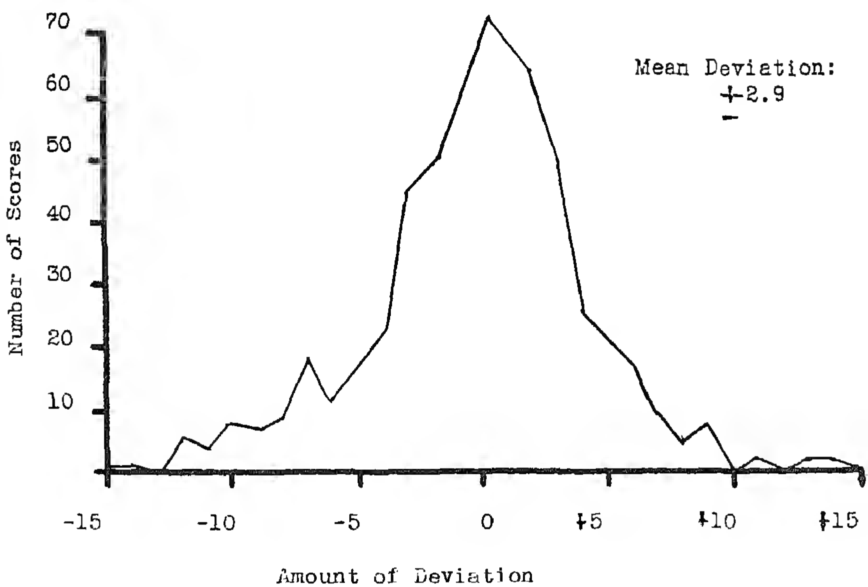


Fig. 3. Distribution of Deviations of Predicted Reading Scores from Actual Stanford Measures (Showing Distributions by Sign of Deviation).

[15] *Appendix C illustrates the fit of the curves with observed performance. The values are expressed as logarithmic in order better to illustrate the rounding off of the curves toward a definite maximum.*

Ignoring signs (+ or -), the average deviation for the whole group was found to be ± 2.9. Considering sign, the mean deviation was found to be zero.

Comparison of Stanford Norms with Boys' and Girls' Curves of Constants

Following the procedure outlined by Courtis,[16] "Curves of Constants" were determined for both boys and girls as follows: Utilizing the ensuing equations, boys' and girls' scores were computed at half-year intervals from seven to eleven, inclusive (Table 1, Figure 4).

$$\text{Boys: } y = 74.7 = [1.123t - 82.20]$$
$$\text{Girls: } y = 75.3 = [1.212t - 87.26]$$

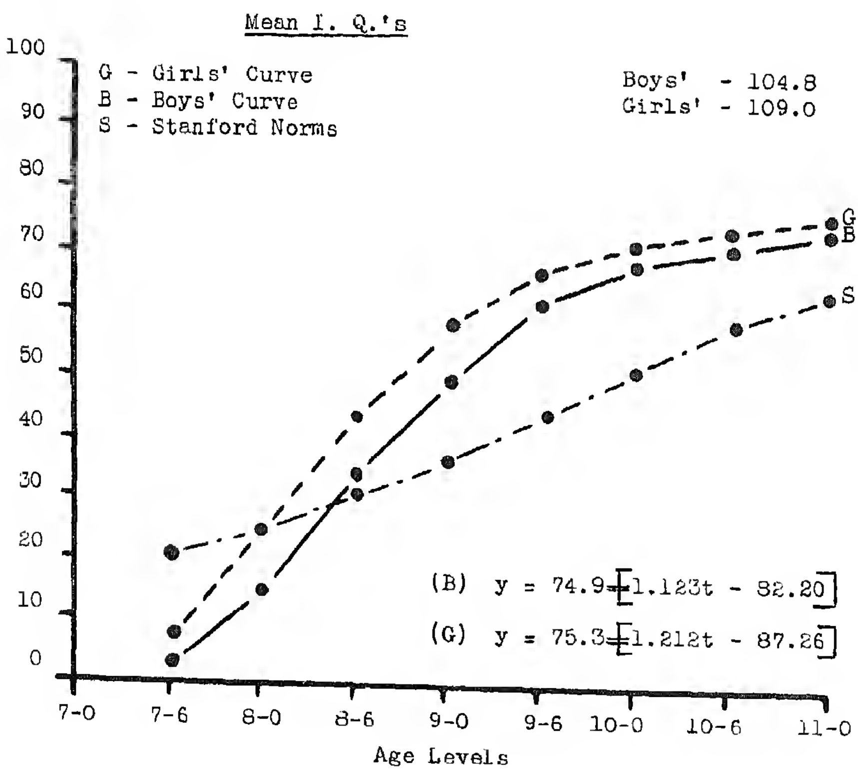


Fig. 4. Comparison of H. F. S. Achievement in Reading with Stanford Norms. (Achievement computed from mean constants of equations).

[16] Courtis, S. A., "The derivation of norms," Section Q. Education, American Association for the Advancement of Science. 1932. pp. 237-242.

The conventional method of determining reading efficiency is to calculate the reading quotient, (R.Q.) which is obtained by dividing the reading age[17] by the chronological age. Utilizing the educational ages, shown in Table 1, reading quotients were calculated (Table 2).

It is interesting, although somewhat disconcerting to the conventionally minded diagnostician, to notice the constant shift of the reading quotient for both boys and girls. Were these reading quotients representative of different boys and girls at each of the various grade levels, the shifting values might have been attributed to differences in ability, or perhaps teaching differences might have been held responsible. Neither of these explanations is tenable, for the various grade levels represent the same children tested as they progressed from grade to grade.

TABLE 1

COMPARISON OF HENRY FORD SCHOOL BOYS' AND GIRLS' READING SCORES WITH STANFORD NORMS

Grade	Age	Stanford Norms		H. F. S. Boys' Scores		H. F. S. Girls' Scores	
		Score	Ed. Age	Score	Ed. Age	Score	Ed. Age
2 - A	7-6	21	90	3.5	*	7.8	*
3 - B	8-0	25	96	15.83	82	25.1	96.5
3 - A	8-6	31	102	33.8	104	44.3	114
4 - B	9-0	37	108	49.8	119	58.2	126
4 - A	9-6	44	114	60.8	128	66.5	134
5 - B	10-0	51	120	67.2	135	70.9	138
5 - A	10-6	58	126	70.8	138	73.1	141
6 - B	11-0	64	132	72.7	140	74.2	142

* Educational Ages not given for scores under 10.

TABLE 2

READING QUOTIENTS* OF H. F. S. BOYS AND GIRLS AT VARIOUS AGES

Grade	Age	(R.Q.) Boys	(R.Q.) Girls
3 - B	8 - 0	85.4	100.5
3 - A	8 - 6	101.9	111.7
4 - B	9 - 0	110.1	116.6
4 - A	9 - 6	112.2	117.5
5 - B	10 - 6	112.5	115.0
5 - A	10 - 6	109.5	111.1
6 - B	11 - 0	106.0	107.5

$$*R.\ Q. = \frac{E.\ A.}{C.\ A.}$$

[17]*See Stanford Norms.*

As a last defense, the conventional analyst might attribute the shifting to variations in conditions underlying the testing program. The fact remains, however, that growth as represented by these children closely approximates a regular, curvilinear development from grade to grade.

The reading quotient, to be valid, should show uniformity from grade to grade when development is as regular as here pictured. The variability of the reading quotient is due to the fallacy in the conventional basis of interpretation which allows a comparison of the growth of individual children with a so-called norm constructed from test scores of a large number of children, where no factor except age is kept under control. The Curves of Constants (Figure 4), and the individual curves, illustrate the fact that growth in reading presents certain curvilinear characteristics which are not comparable with the approximate straight-line norms of the Stanford Tests.

Conclusion

It is interesting to note that at 8 - 0 years of age for girls and at 8 - 6 years of age for boys, performances of the Henry Ford School children, below "normal" before this time, reach and surpass the reading norms. Reading quotients (Table 2), obtained from the educational ages of the Henry Ford School children (Table 1), show but little constancy ranging from below 85.4 to 112.5 for boys, and from below 100.5 to 117.5 for girls. Since this ratio is often used to determine reading efficiency, the results shown here illustrate the fallacy of the scheme. Since this method of measuring achievement has been advocated by almost all leading writers on educational diagnosis, until it has become almost universally practiced, the injustice done thousands and thousands of pupils by this procedure is illustrated by these data.

Another grave injustice which is almost as prevalent can likewise be illustrated here. Utilizing the achieved scores of the Henry Ford School children, the interpretation ordinarily made would be that teaching at the levels where the R. Q. is highest, for boys in grades 4A and 5B, and for girls in grades 4B and 4A (Table 2), is responsible for the high achievement. Nothing could be further from the truth! Performance achieved at these levels can be accurately predicted from scores at lower grade levels. Consequently the factors which brought the scores to their highest point above the norm are factors which were already in operation throughout the early part of the curve.

The conclusion must be made that the concept of norms needs revision. Evidence such as shown in this chapter points out the injustice done many children by comparing their scores with so-called norms which take no account of individual differences in growth.

SEX DIFFERENCES IN READING PERFORMANCE

Probably no other phase of the school curricula has induced as much research as has the field of reading. Individual differences have been studied. The effect of intelligence upon reading performance has been investigated time after time. Methods of teaching children to read have been devised, applied, and appraised, and the physiological implications

of reading performance have received intensive study. As yet, however, few outstanding investigations have been made of sex differences in reading. One would certainly not be labeled an extremist, in view of these facts, to say that sex as a factor in reading performance has not been regarded as significant. Whether or not sex differences have been justifiably ignored remains to be seen. In other curricular fields, the effect of sex has been studied. Numerous investigators have carefully analyzed sex differences in spelling. In various phases of arithmetic, differences in the performance of boys and girls have been given considerable attention.

Our tendency today to make the best possible provisions for the individual child necessitates, to say the least, some attention to the effect of sex upon reading performance. The problem of reading readiness with its implications regarding the time at which formal reading should be introduced, suggests probable sex differences, as well as individual differences. The superior physical maturity of girls over boys at the upper elementary grade level suggests the possibility of an accompanying reading superiority. The problem receives added import when looked at from the point of view of child development. Certainly no investigator today, in the field of child study, would think of combining boys' and girls' scores in studying the effects of factors conditioning growth. If boys' and girls' measures are to be treated singly, what are the differences, then, that characterize the development of each?

The objective of this chapter is to analyze differences in the reading scores of boys and girls at the pre-adolescent level, and to study mathematically the relationships which are produced by such differences as may occur.

Treatment of Data

Subjects: Two different groupings of boys and of girls were available for this phase of the investigation.

1. All boys (55) and all girls (63) as shown in Appendices A and B;
2. Boys and girls (43 pairs), matched according to their I.Q.'s, as shown below:

Cases

Pair	Case Numbers Boys-Girls	Approximate I.Q.
1	36 - 17	85
2	23 - 33	90
3	24 - 7	90
4	35 - 42	90
5	21 - 51	95
6	60 - 48	95
7	37 - 1	100
8	95 - 80	100
9	48 - 29	100
10	61 - 31	100
11	16 - 43	100

Cases (Continued)

Pair	Case Numbers Boys-Girls	Approximate I.Q.
12	71 - 9	105
13	11 - 18	105
14	45 - 26	105
15	8 - 64	105
16	15 - 21	105
17	19 - 78	105
18	26 - 32	105
19	27 - 52	105
20	34 - 28	105
21	31 - 71	105
22	42 - 3	105
23	70 - 59	105
24	77 - 65	105
25	22 - 41	110
26	44 - 68	110
27	1 - 15	110
28	2 - 49	110
29	3 - 70	110
30	13 - 82	110
31	14 - 69	110
32	52 - 13	110
33	18 - 38	110
34	46 - 5	110
35	40 - 12	115
36	41 - 4	115
37	51 - 62	115
38	9 - 74	115
39	10 - 77	115
40	17 - 19	115
41	28 - 25	120
42	12 - 35	120
43	49 - 55	125

Mean I.Q. - 106.1

Method of Analysis: Utilizing the equations of constants (p. 80), scores were computed at regular age intervals and comparisons were made in terms of score, rate of growth, the age established for the beginning of growth (b), the age established for the completion of growth (t), and the time required for growth (c).[18]

[18]*In applying the growth technique to successive performance measures, it is not necessary to match children according to age, since the growth equation derived describes growth throughout the entire cycle. The isochronic equation regards growth at any part of the learning curve as equal to growth at any other part, providing the unit of time is the same throughout. Therefore, growth at the upper part of one learning curve can be compared with growth at an entirely different part in another curve, other things being equal, or when other differences in conditions underlying the two growths are known or measurable.*

Results

(1) <u>Comparison of Reading Scores of Unmatched Boys and Girls</u>: According to the scores computed from the equations

$$y = 74.9 = [= 1.123t - 82.20] - \text{Boys}$$
$$y = 75.3 = [= 1.212t - 87.26] - \text{Girls}$$

of the means of constants, the reading performance of girls is superior at each age level throughout the cycle (Figure 4). From the conventional point of view, the greatest difference is found at the age of eight years and six months. At this age the girls' score exceeds the boys' by more than ten points (Table 3). A comparison of the educational ages achieved shows the greatest superiority in favor of the girls to be found at the age of eight years (Table 3). Ratios between isochronic developments[19] show a degree of uniformity in achievement which is not shared by either the Stanford scores or the educational ages (Table 3).

Since the maxima toward which the two groups are developing are approximately equal, 74.7 for boys and 75.3 for girls with a ratio of 1.00 (Table 3), the possibility is available of making comparisons mathematically with the "K" in the equation, $y = K = [= rt \pm i]$, eliminated. The equation then becomes $y = rt \pm i$.

Since "t" is a common element in both equations, and since the values for "i" are only used to express differences in time at which growth begins, a measure, in this instance, is available which expresses throughout the entire development a consistent measure of the superiority of girls over boys, namely, the ratio of the rates of growth. For these two groups this ratio is found to be 1.079 (Table 3). Another available measure, described previously as the developmental ratio (D. R.), is also utilized. This value, 1.08, is consistent with the rate ratio shown above.[20] The developmental ratio shows that the girls require a shorter growth period than the boys. Expressed precisely, the D. R. is inversely proportional to the time required for equal developments.

Other differences in the character of the two curves remain to be described. As indicated by the mean "i" in the equations, the girls begin the cycle of development at a mean age of 72 months, whereas the boys begin this particular reading growth at a mean age of 73.2 months, a difference of slightly more than one month (Figure 6B). A difference of six months is found, however, between the mean ages at which the two groups arrive at maturity (mathematically computed at 99 per cent of maturity) (Figure 6D). Other differences, maximum growth and time required for maturation are not significant (Figures 6A and 6C).

In the section immediately preceding, it was pointed out that differences were found to exist in the reading achievements of the two groups which were distinctly in favor of the girls. The two groups were not equal in number, nor were they of equal intelligence. In the second phase of this study the effect of intelligence was controlled by utilizing the scores of the forty-three matched pairs. By averaging the

[19]The "developments" are the values obtained from the portion of the general equation, $y = K = [= rt + i]$, found within the brackets $= [=]$. Developments do not make allowances for differences in maxima (K) and must not be utilized unless maxima are equal, or differences accounted for.

[20]D. R. obtained by dividing the boys' age at which the cycle is completed by the girls' age involves a comparison of the times required to make equal developments.

TABLE 3

DIFFERENCES IN READING PERFORMANCE OF H. F. S. BOYS AND GIRLS
AT VARIOUS AGE LEVELS. UNMATCHED GROUPS

Ages	Score[1]				Educational Age[2]				Isochronic Development[3]			
	Girls	Boys	Diff.	Ratios (G ÷ B)	Girls	Boys	Diff.	Ratios (G ÷ B)	Girls	Boys	Diff.	Ratios (G ÷ B)
7-6	7.8	3.5	4.3	2.22	—	—	—	—	21.82	18.87	2.95	1.15
B-0	25.1	15.8	9.3	1.58	96	82	14	1.15	29.09	25.60	3.49	1.13
B-6	44.3	33.8	10.5	1.31	114	104	10	1.09	36.36	32.34	4.02	1.12
9-0	58.2	49.8	B.4	1.16	126	119	7	1.05	43.63	39.08	4.55	1.11
9-6	66.5	60.8	5.7	1.08	134	128	6	1.04	50.90	45.82	5.0B	1.11
10-0	70.9	67.2	3.7	1.05	138	135	3	1.02	58.1B	52.56	5.62	1.10
10-6	73.1	70.8	2.2	1.03	141	13B	3	1.02	65.45	59.29	6.16	1.10
11-0	74.2	72.7	1.5	1.02	142	140	2	1.01	72.72	66.05	6.69	1.10

[1]Score - Computed from Equation of Curves of Constants. [2]Educational ages found by referring computed scores to the Stanford norms. [3]Isochronic Development determined from Equation of Curves of Constants.

I. Q.'s: Boys - 104.B; Girls - 109.0; Ratio (G ÷ B) = 1.04

Constants in Equations

a. Rates of Growth . . . . Boys - 1.123 Girls - 1.212 Ratio (G ÷ B) = 1.079
b. Beginning of Growth . . . Boys - 73.2 mos. Girls - 72.0 mos. Diff. (B − G) = 1.2 mo.
c. Time required for Growth. Boys - 70.2 mos. Girls - 65.0 mos. Ratio (B ÷ G) = 1.08
d. Age at Completion of Growth . . . . Boys - 143 mos. Girls - 137 mos. Diff. (B − G) = 6.0 mo.
e. Maxima. . . . . Boys - 74.7 Girls - 75.3 Ratio (G : B) = 1.00

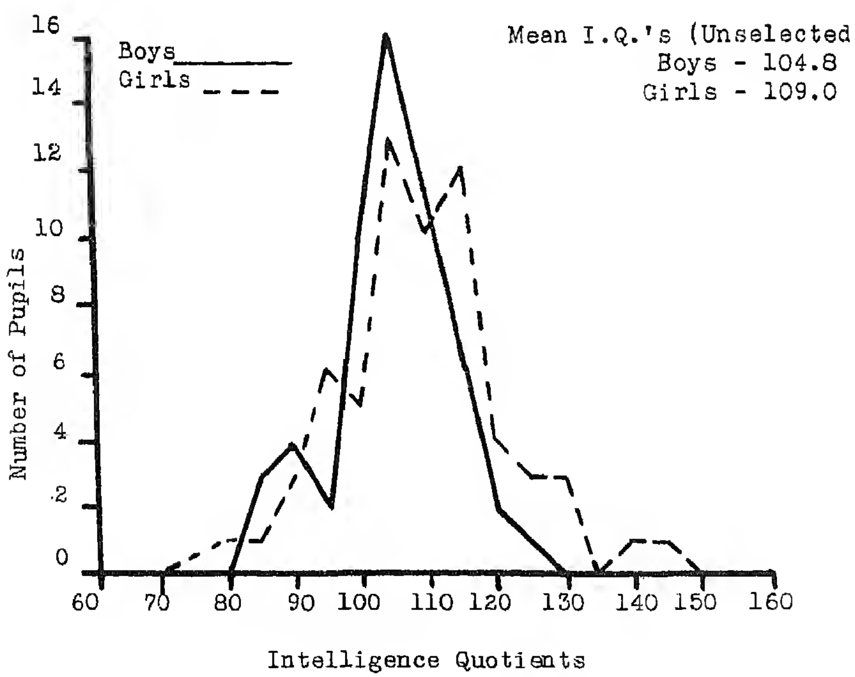


Fig. 5. Distribution of I.Q.'s by Sex. Unmatched Boys and Girls.

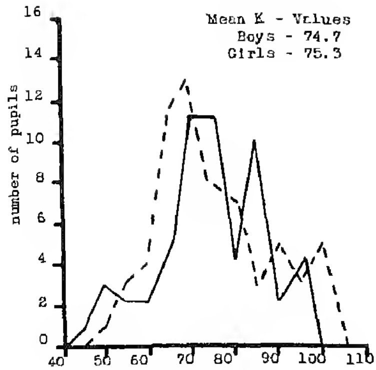


Figure 6A. Sex Differences in K - Values

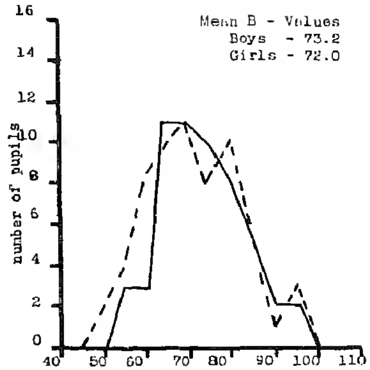


Figure 6B. Sex Differences in Age of Beginning Reading

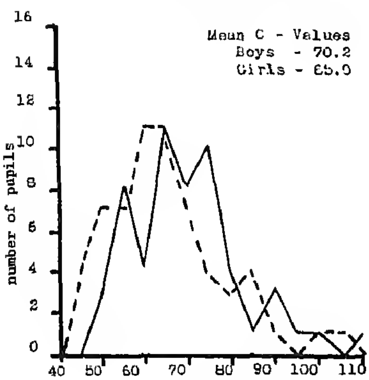


Figure 6C. Sex Differences in Time Required for Complete (99%) Maturation

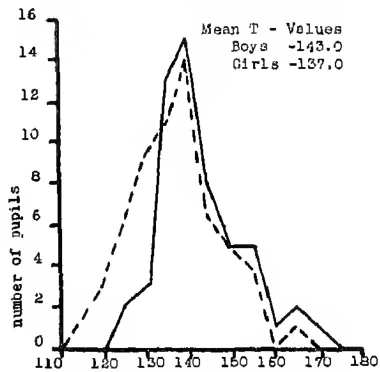


Figure 6D. Sex Differences in Ages at Which Complete (99%) Maturation Occurs

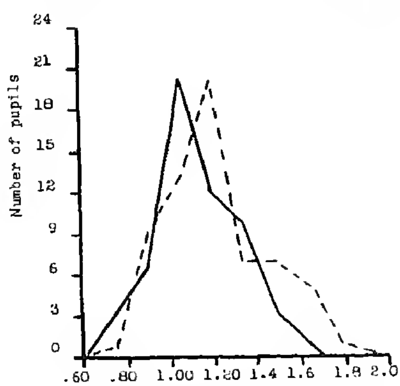


Figure 6E. Sex Differences in Rates of Growth

Fig. 6. Sex Differences in Pre-Adolescent Reading Constants (Unmatched Boys and Girls). Boys ________ Girls _ _ _ _ _

constants in the equations of these children, the following equations resulted:

$$y = 75.96 = [= 1.144t - 83.51] - \text{Boys}$$
$$y = 73.21 = [= 1.192t - 86.53] - \text{Girls}$$

Using these equations in computing scores at various ages throughout the cycle, quite marked changes in results are found from those obtained with the unmatched groups.

From the conventional diagnostic approach, it would be necessary to conclude from these latter data that girls are better readers in the earlier elementary grades, but that the boys catch up with and pass the girls at the later elementary levels (Table 4, Figure 7). At eight years of age girls are five months advanced over boys in reading achievement. This superiority gradually decreases until age ten is reached, at which time the boys show superiority in reading achievement.

If the achievements are now considered from the "growth" point of view, very consistent conclusions are obtained, in spite of complications due to equation differences in the maxim toward which the two groups are growing.[21]

The isochronic ratios (Table 4), show a slight variation in the superiority of the girls ranging from four to six per cent. In comparing the growth equations of these two groups, it is found that the starting times are practically equal (Table 4, Figure 9), there being a difference of only 0.4 of a month. With equal starting points the isochronic developments would have provided an accurate comparative developmental measure had the two groups been growing toward the same maximum. Since the two groups do not have the same maximum, the isochronic developments do not express an accurate ratio between the two growths. Likewise, since the "K's" in the equations are not equal, "K" cannot be eliminated from consideration as in the diagnosis of the unmatched groups. Therefore, neither the developmental ratio as determined by the rate ratios (1.041 in Table 4), nor the developmental ratio as determined by the ratio between the "times" required for equal developments, (from Table 4

$$\frac{142.1 \text{ (Boys' Age at Completion of Growth)}}{136.5 \text{ (Girls' Age at Completion of Growth)}} = 1.041)$$

can be used as measure of comparative developments.

To interpret differences in the two growths accurately, allowances must be made for the different maxima. Regardless of rates of growth and time required for equal developments, a comparison of achievements, as we now think of it, must take into consideration differences in maxima toward which the groups are growing. This idea implies that one boy, for example, who has a faster growth rate and requires a shorter time to reach maturity of a given cycle is not considered superior to another boy as long as his maximum achievement falls below the maximum achievement for the second boy who nevertheless has a slower growth rate and a longer maturation period.

There are no available techniques which may be employed in determining relationships between "quality" (growth rate), and "capacity" as

[21] *Note that in the preceding diagnosis of unmatched groups the two maxima were approximately equal.*

TABLE 4

DIFFERENCES IN READING PERFORMANCE OF H. F. S. BOYS AND GIRLS AT VARIOUS AGE LEVELS. MATCHED GROUPS[4]

Ages	Score[1]				Educational Ages[2]				Isochronic Development[3]			
	Girls	Boys	Diff.	Ratios (G ÷ B)	Girls	Boys	Diff.	Ratios (G ÷ B)	Girls	Boys	Diff.	Ratios (G ÷ B)
7-6	5.95	4.32	1.62	1.35	—	—	—	—	20.75	19.45	1.30	1.06
8-0	21.30	17.85	3.45	1.13	90	85	5	1.05	27.90	26.31	1.59	1.06
8-6	40.04	36.68	3.36	1.09	111	107	4	1.03	35.05	33.17	1.88	1.05
9-0	54.46	52.64	1.82	1.03	123	121	2	1.01	42.20	40.04	2.16	1.05
9-6	63.32	63.12	0.20	1.00	131	131	0	1.00	49.35	46.90	2.45	1.05
10-0	68.15	69.19	-1.04	.99	136	137	-1	.99	56.51	53.77	2.74	1.05
10-6	70.64	72.46	-1.82	.97	138	140	-2	.98	63.56	60.63	2.93	1.04
11-0	71.96	74.13	-2.17	.97	139	142	-3	.97	70.81	67.49	3.32	1.04

1 - 2 - 3 - were computed as explained in Table 3

[4] I. Q.'s. . . . Boys, 106.1; Girls, 106.1; Ratio, 1.00

<u>Constants in Equations</u>

a. Rates of Growth . . . . Boys - 1.144; Girls - 1.192; Ratio - (G ÷ B) = 1.04

b. Beginning of Growth . . . . Boys - 73.2 mos., Girls - 72.6 Diff. - (B - G) = 0.4 mo.

c. Time Required for Growth. . Boys - 69.1 mos., Girls - 65.9 Ratio - (B ÷ G) = 1.04

d. Age at Completion of Growth . . . . Boys - 142.1 mos., Girls - 138.5 Diff. - (B - G) = 3.6 mos.

e. Maxima. . . . . Boys - 75.96; Girls - 73.21; Ratio - (G : B) = .96

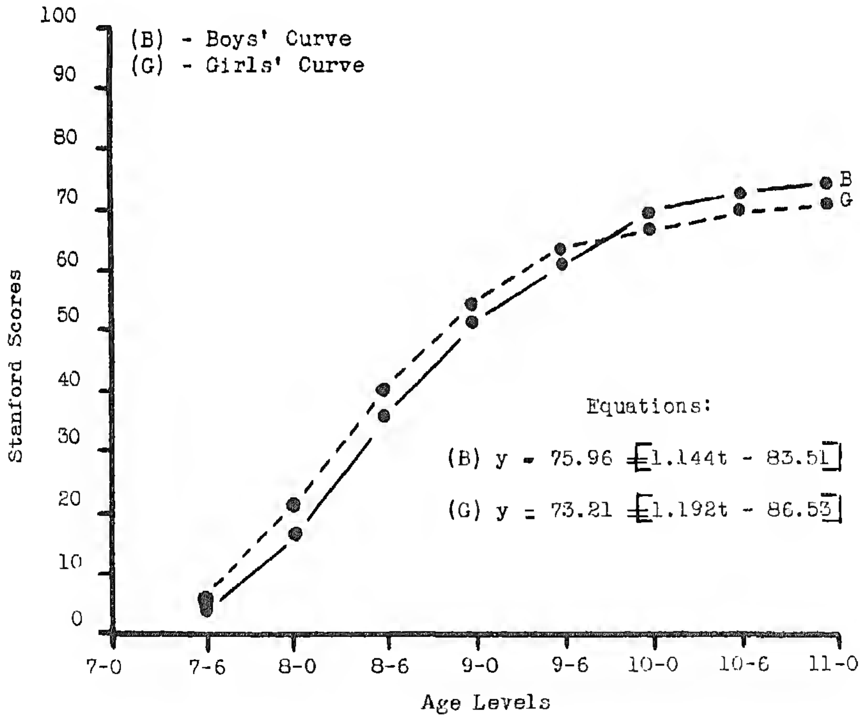


Fig. 7. Comparison of Reading Achievement of Boys and Girls of Equal I.Q.'s.

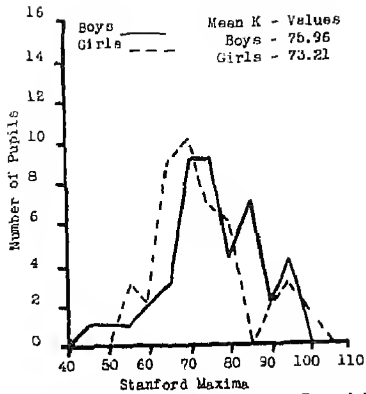


Fig. 8A. Individual Differences in Pre-Adolescent K-Reading Values. (Showing Distribution by Sex of Boys and Girls Unmatched According to I.Q.)

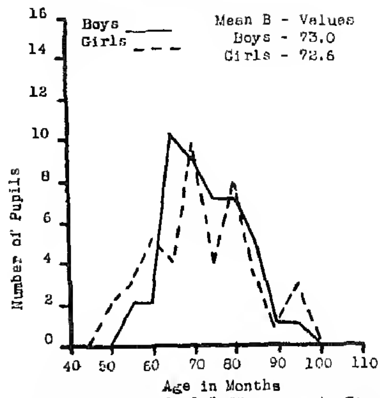


Fig. 8B. Individual Differences in Time at which Reading Growth Begins. (Showing Distribution by Sex of Boys and Girls Matched According to I.Q.)

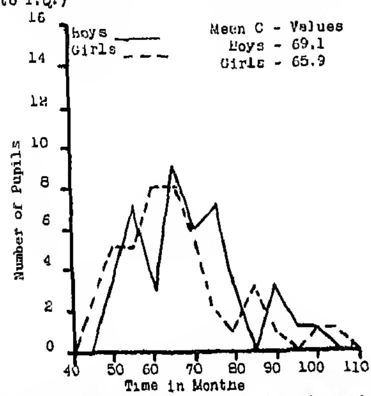


Fig. 8C. Individual Differences in Ages at which Complete Maturation (99.0) of the Pre-Adolescent Reading Curve Occurs. (Boys and Girls Matched According to I.Q.)

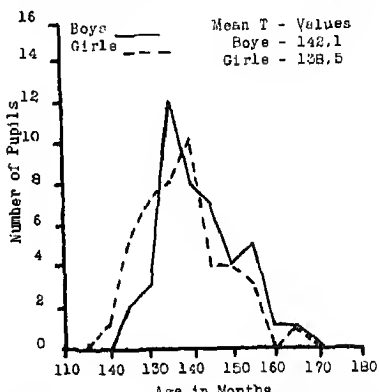


Fig. 8D. Individual Differences in Pre-Adolescent Rates of Growth in Reading. (Boys and Girls Matched According to I.Q.)

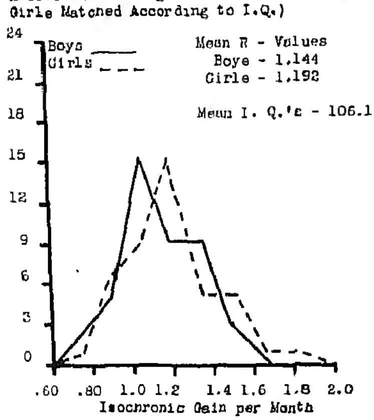


Fig. 8E. Individual Differences in Pre-Adolescent Rates of Growth in Reading. (Showing Distribution by Sex of Boys and Girls Matched According to I.Q.)

Fig. 8. Sex Differences in Pre-Adolescent Reading Constants. Mean I.Q.'s: 106.1 (Matched Boys and Girls).

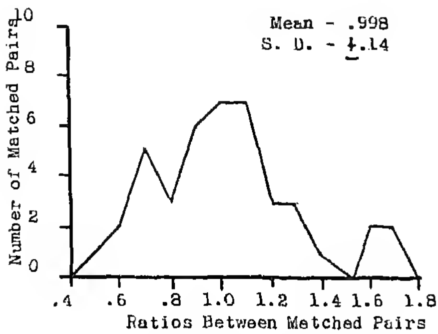


Figure 9. Distribution of Ratios Between Members of Matched Pairs after Equalizing Differences Due to Sex.

$$\frac{G}{B} = \frac{\text{Rate of Growth (G)}}{\text{Rate of Growth (B)}} \times \frac{\text{Maximum (G)}}{\text{Maximum (B)}}$$

expressed by the maximum. The only method of procedure available is that of formulating a tentative solution and testing by the facts forthcoming.

Proceeding on this basis the data are again approached. Whereas the girls show greater development at a given age (a greater maturity value at a given time), they are growing toward a lesser maximum (Table 4). Immediately a solution suggests itself in a multiplicative ratio between rates of growth and maxima. That is, $\frac{\text{Girls}}{\text{Boys}} = \frac{\text{Rate (G)}}{\text{Rate (B)}} \times \frac{\text{Max. (G)}}{\text{Max. (B)}}$.

Mathematically, from the equations (p. 88), $\frac{G}{B} = \frac{1.192}{1.144} \times \frac{73.21}{75.96} = .9984$;

or, expressed for each pair,

(a) Boys' Rate of Growth = Girls' Rate of Growth x $\frac{(\text{MaxG})}{(\text{MaxB})}$, or

(b) Girls' Rate of Growth = $\dfrac{\text{Boys' Rate of Growth}}{\frac{\text{Max.G}}{\text{Max.B}}}$

Utilizing the above equation, rates were equated for each of the forty-three pairs and the ensuing ratios graphed. The few pairs available (43) form a fairly good distribution around a 1 to 1 ratio (S. D. ± .14), but with wide individual variations.

Conclusion: Although there are characteristics of the reading achievement curve which can be attributed to the effect of sex, differences in rates of growth, differences in time at which maturity is reached, and differences in maxima, there is no basic difference in achievement when all of these factors are taken into consideration.[22]

[22] *The writer is fully aware of the possibility of an adolescent effect upon performance which has not been considered here. There is the possibility also that a sex characteristic has been ruled out by I.Q. matching.*

THE EFFECT OF INTELLIGENCE UPON READING PERFORMANCE

Studies of the effect of intelligence upon reading performance are too numerous to mention. Let it be sufficient to state that in the conclusion that reading achievement correlates highly with measures of intelligence there is general agreement. The range of positive correlation lies somewhere between the +.489 found by Gates[23] and the +.720 reported by Reed.[24]

The purpose of this section is to note the effect of differences in intelligence upon reading development, as portrayed by individual growth curves in reading.

Treatment of Data

Subjects: Since I.Q.'s were available for all cases it was possible to divide both boys and girls into two groups, one to be called the Upper Boys (or Girls) and the other to be called the Lower Boys (or Girls). Had a large number of cases been available, it would have been advisable to have made comparisons of the mean reading constants of groups of children at several intelligence levels. However, the comparatively small number of cases available rendered this scheme impractical. As a result the following groupings were made:

Boys' Cases		Girls' Cases	
High (105 Up)	Low (104 Down)	High (111 Up)	Low (110 Down)
1m - 111	5m - 86	2f - 127	1f - 100
2m - 111	7m - 90	5f - 112	3f - 107
3m - 111	16m - 101	8f - 117	6f - 95
4m - 107	95m - 100	10f - 120	7f - 90
8m - 106	21m - 96	13f - 111	9f - 103
9m - 115	23m - 88	12f - 113	11f - 81
10m - 115	24m - 88	4f - 113	15f - 109
11m - 105	25m - 102	19f - 115	17f - 84
12m - 122	31m - 103	22f - 125	18f - 103
13m - 111	35m - 88	24f - 119	21f - 104
14m - 111	36m - 85	25f - 118	26f - 103
15m - 106	37m - 98	27f - 117	28f - 106
17m - 115	42m - 103	35f - 118	29f - 102
18m - 112	48m - 100	37f - 140	31f - 102
19m - 106	50m - 101	38f - 111	32f - 105
20m - 107	55m - 102	40f - 129	33f - 89
22m - 109	60m - 97	45f - 128	34f - 96
26m - 106	61m - 100	50f - 117	41f - 108
27m - 106	63m - 102	53f - 116	42f - 91
28m - 119	65m - 86	55f - 123	43f - 102
30m - 107	70m - 103	62f - 114	48f - 94
34m - 106	71m - 104	63f - 144	49f - 109
40m - 114	77m - 103	74f - 114	51f - 93

[23]Gates, A. I., *Psychology for students of education.* New York: The Macmillan Company, 1925, pp. 441-443.

[24]Reed, F. R., *Psychology of elementary school subjects.* New York: Ginn and Co., 1927, pp. 66-69.

Boys' Cases: High (105 Up)	Boys' Cases: Low (104 Down)	Girls' Cases: High (111 Up)	Girls' Cases: Low (110 Down)
41m - 114	80m - 101	76f - 115	52f - 105
44m - 110	------	77f - 114	58f - 95
45m - 105	------	81f - 131	59f - 107
46m - 112	------	84f - 115	64f - 103
49m - 124	------	------	65f - 107
51m - 114	------	------	68f - 108
52m - 111	------	------	69f - 110
72m - 112	------	------	70f - 109
------	------	------	71f - 106
------	------	------	78f - 104
------	------	------	80f - 100
------	------	------	82f - 109
------	------	------	83f - 97
Mean I.Q. 111.0	Mean I.Q. 97.0	Mean I.Q. 119.8	Mean I.Q. 101.0

Curves of Constants were then determined for the four groups of pupils, and scores were computed at various age levels from the equations (Tables 5 and 6).

Results

For both boys and girls the computed achievements of the Upper Groups are markedly superior to those of the Lower Groups (Tables 5 and 6, Figures 10 and 11).

Scores, educational ages, and isochronic developments all testify to

TABLE 5

DIFFERENCES IN READING PERFORMANCE AT VARIOUS AGE LEVELS OF BOYS' GROUPS DIFFERING IN MEAN INTELLIGENCE[4]

Age	Score[1]				Educational Ages[2]				Isochronic Development[3]			
	Upper	Lower	Diff.	Ratios (U ÷ L)	Upper	Lower	Diff.	Ratios (U ÷ L)	Upper	Lower	Diff.	Ratios (U ÷ L)
7-6	9.5	.4	9.1	23.75	—	—	—	—	22.96	13.86	9.10	1.65
8-0	28.5	5.1	23.4	5.58	99	—	—	—	29.74	20.56	9.18	1.44
8-6	47.3	18.2	29.1	2.59	117	86	31	1.36	36.53	27.26	9.27	1.34
9-0	61.2	34.7	26.5	1.75	129	106	23	1.21	43.31	33.96	9.35	1.27
9-6	69.7	48.3	21.4	1.44	138	118	20	1.17	50.10	40.66	9.44	1.23
10-0	74.4	57.1	17.3	1.30	142	126	16	1.12	56.89	47.36	9.53	1.20
10-6	76.9	62.3	14.6	1.23	146	130	16	1.12	63.67	54.07	9.60	1.17
11-0	78.2	65.1	13.0	1.19	147	133	14	1.10	70.46	60.77	9.69	1.15

[1]Scores Computed from Equations of Curves of Constants. [2]Educational Ages found by referring computed scores to Stanford Norms. [3]Isochronic Development determined from Equations of Curves of Constants. [4]Mean I. Q.'s, Upper Boys, 111.0; Lower Boys, 97.0; Ratio, (U ÷ L) = 1.14

Constants in Equations

a. Rates of Growth . . . . . . .Upper Boys - 1.131; Lower Boys - 1.117; Ratio (U ÷ L) = 1.01
b. Beginning of Growth. . . .Upper Boys - 69.7 mos. " " - 77.6 mos. " (L ÷ U) = 1.11
c. Time Required for Growth . " " - 70.3 mos. " " - 70.0 mos. " (U ÷ L) = 1.00
d. Age at Completion of Growth . . . . " " -139.6 mos. " " -147.6 mos. " (L ÷ U) = 1.06
e. Maxima . . . . " " - 79.7; " " - 68.2; " (U:L) - 1.17

TABLE 6

DIFFERENCES IN READING PERFORMANCE AT VARIOUS AGE LEVELS OF GIRLS' GROUPS DIFFERING IN MEAN INTELLIGENCE[4]

Ages	Score[1]				Educational Age[2]				Isochronic Development[3]			
	Upper	Lower	Diff.	Ratios (U + L)	Upper	Lower	Diff.	Ratios (U + L)	Upper	Lower	Diff.	Ratios (U + L)
7-6	22.5	2.2	20.3	10.22	92				27.27	17.76	9.51	1.53
8-0	44.6	13.1	31.5	3.40	115	78	37	1.47	34.63	24.96	9.67	1.38
8-6	62.0	31.0	31.0	2.00	130	102	28	1.27	42.00	32.16	9.84	1.30
9-0	72.5	46.5	26.0	1.55	140	116	24	1.20	49.37	39.36	10.01	1.25
9-6	78.1	56.9	21.2	1.37	147	126	21	1.16	56.74	46.56	10.18	1.21
10-0	81.1	62.8	18.3	1.29	151	130	21	1.16	64.11	53.76	10.35	1.19
10-6	82.4	65.8	16.6	1.25	152	134	18	1.13	71.47	60.96	10.51	1.17
11-0	83.1	67.4	15.7	1.22	154	135	19	1.14	78.84	68.16	10.68	1.15

[1]Scores computed from equations of Curves of Constants. [2]Educational Ages found by referring computed scores to the Stanford Norms. [3]Isochronic Development determined from Equations of Curves of Constants. [4]Mean I. Q.'s, Upper Girls, 119.8; Lower Girls, 101.0; Ratio, (U + L) = 1.18

Constants in Equations

		Upper Girls	Lower Girls	Ratio
a.	Rates of Growth.	Upper Girls - 1.228;	Lower Girls - 1.200;	Ratio (U + L) = 1.02
b.	Beginning of Growth. . . .	" " -67.8 mos.	" " - 75.2 mos.	" (L + U) = 1.10
c.	Time Required for Growth .	" " -64.4 mos.	" " - 65.4 mos.	" (L + U) = 1.01
d.	Age at Completion of Growth	" " -132.3 mos.	" " - 140.6 mos.	" (L + U) = 1.06
e.	Maxima	" " -83.8;	" " - 69.0;	" (U + L) = 1.21

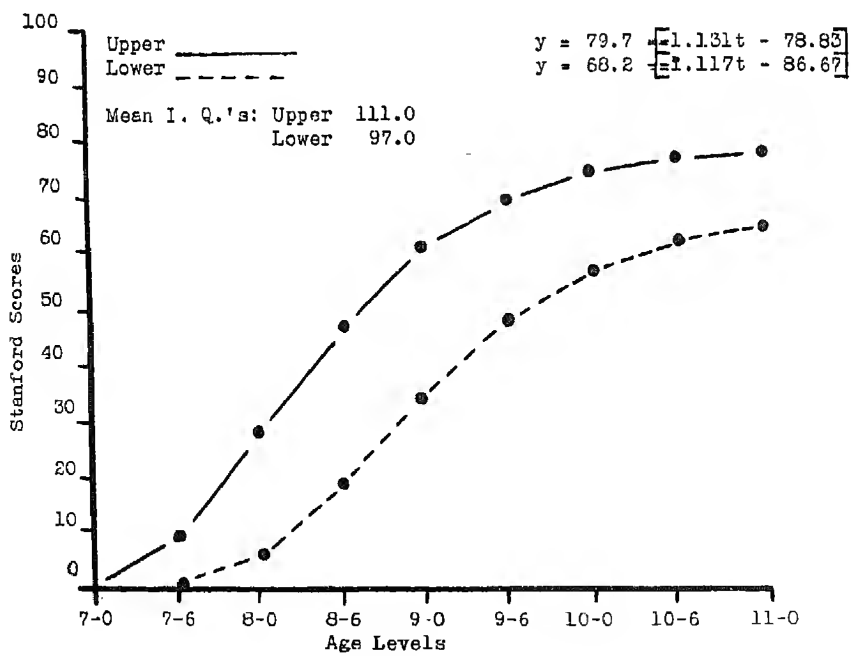


Fig. 10. Comparison of Reading Performances of Two Groups of Boys at Different I.Q. Levels.

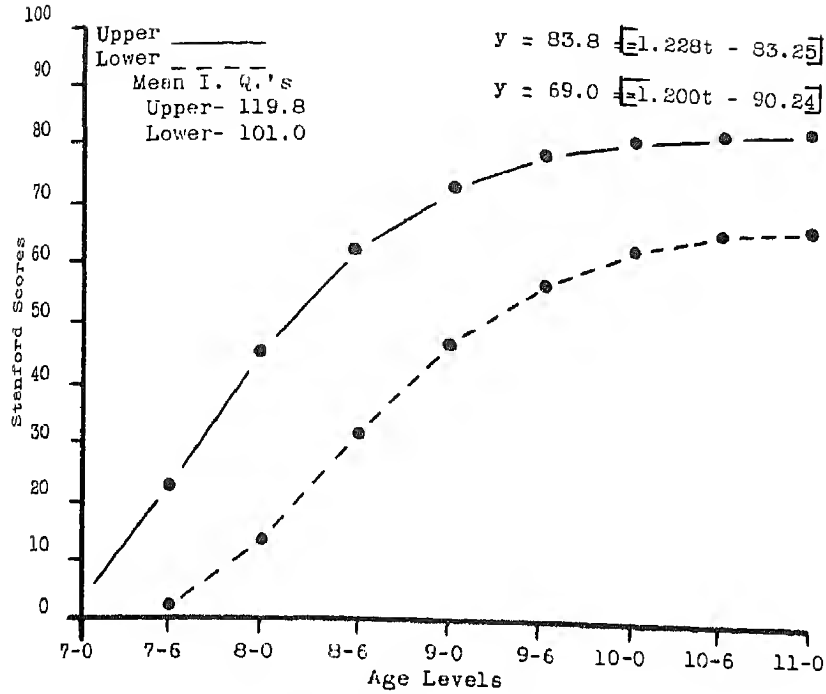


Fig. 11. Comparison of Reading Performances of Two Groups of Girls at Different I.Q. Levels.

the influence of intelligence as a factor in reading performance. Variability in the ratios obtained between performances of the two intelligence levels suggests widely different characteristics of growth (Tables 5 and 6).

The more intelligent children, both boys and girls, are growing toward higher maxima, and begin and end their reading developments at earlier ages than the lower groups. On the other hand, rates of growth are nearly equal and the times required for developments are approximately the same (Tables 5 and 6).

The only ratio which approximates the ratio between the I.Q.'s of the Upper and Lower Groupings is that found between maxima. In each of the two comparisons, these ratios are but slightly larger than the I.Q. ratios.

Utilizing the correlation method, the relationships suggested by the ratios between constants of the comparable groups were verified (Table 7). Very high positive correlations (.73) were found to exist between the maximum toward which the child is growing and his intelligence quotient. Significant negative correlations, from .41 to .59, were likewise found to exist between the child's intelligence level and the ages at which he

TABLE 7

COEFFICIENTS OF CORRELATION BETWEEN I.Q.'s AND ELEMENTS OF GROWTH IN READING ACHIEVEMENT AS MEASURED BY STANFORD SCORES

Elements of Growth	Boys' I. Q.'s	Girls' I. Q.'s
[1]R	+ .12	+ .05
[2]b	- .41	- .51
[3]c	- .0001	- .0210
[4]T	- .45	- .59
[5]K	+ .731	+ .737

[1]R - Isochronic Rate of Growth

[2]b - Age at which Growth Begins

[3]c - Number of Months Required for Complete Maturation (99.0%)

[4]T - Age at which Growth is completed

[5]K - Maximum Score Toward which Growth is Progressing

begins and completes his reading cycle. Lines of regression are shown in Figures 12 and 13.

Prediction of Intelligence from Reading Scores: The foregoing pages have demonstrated the existence of certain relationships between reading performance, as measured by the Stanford tests, and intelligence measures. The question may now be asked, "To what extent is it possible to determine individual intelligence indices from a knowledge of a child's growth in reading achievement?" Since such high correlations were found to exist between the reading maxima and the respective I.Q. levels, the question may be repeated even more specifically, "To what extent can individual intelligence indices, comparable to the I.Q., be determined from individual maxima?" Utilizing the equation

$$\frac{I.Q.^*}{I.Q.} = \frac{K^*}{K}$$

which implies the "brighter" the child the higher his reading maximum,

*Developmental Ratio was determined from the equation, $D.\ R. = \dfrac{\text{Time Required by Individual for Complete Maturation } (T_1)}{\text{Time Required for Group for Complete Maturation } (T)}$

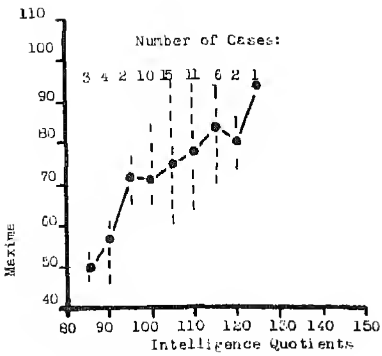


Figure A. Relationship Between I. Q.'s and Boys' Median Maxima

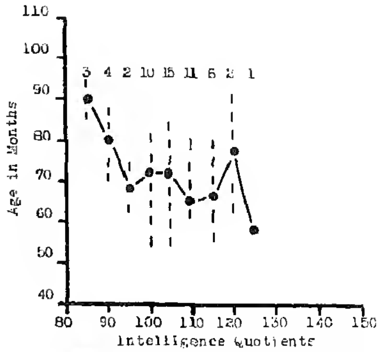


Figure B. Relationship Between I. Q.'s and Boys' Median Age at which Reading Achievement Begins

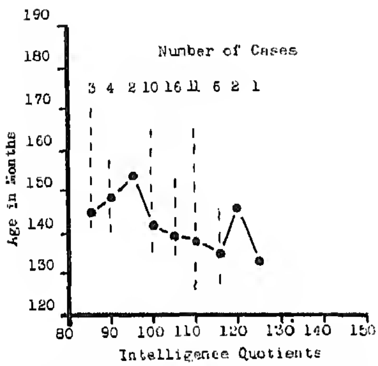


Figure C. Relationship Between I. Q.'s and Boy's Median Age at which Reading Achievement Reaches Maturity

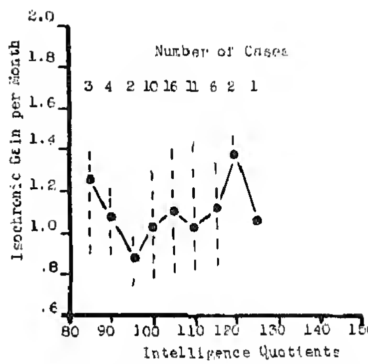


Figure D. Relationship Between I. Q.'s and Boy's Median Rates of Growth in Reading

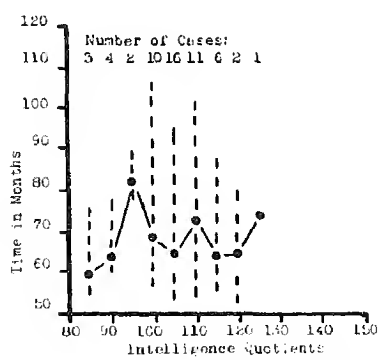


Figure E. Relationship Between I. Q.'s and Boy's Median Time Required for Complete Maturation.

Fig. 12. Relationship Between I.Q.'s and Computed Constants in the Reading Equation (Boys).

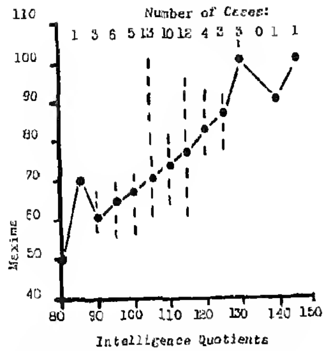


Figure A. Relationship Between I. Q.'s and Girl's Median Maxima

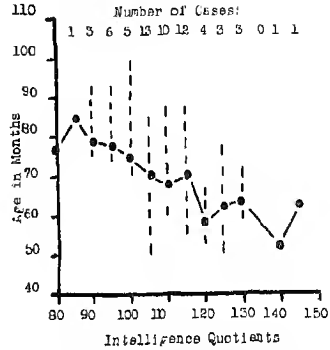


Figure B. Relationship Between I. Q.'s and Girl's Median Age at which Reading Achievement Begins

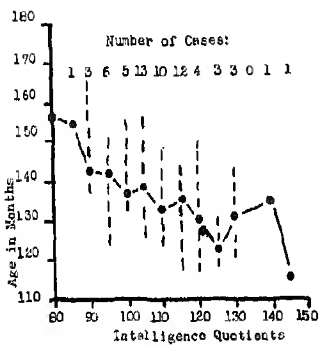


Figure C. Relationship Between I. Q.'s and Girl's Median Age at which Reading Achievement Reaches Maturity

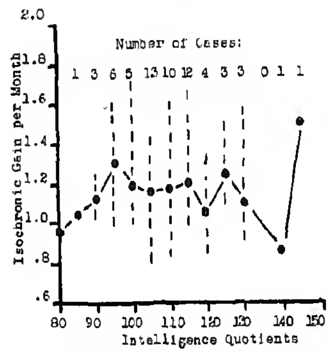


Figure D. Relationship Between I. Q.'s and Girl's Median Rates of Growth in Reading

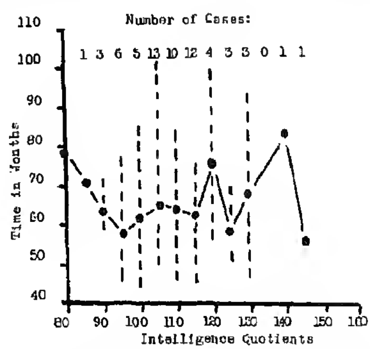
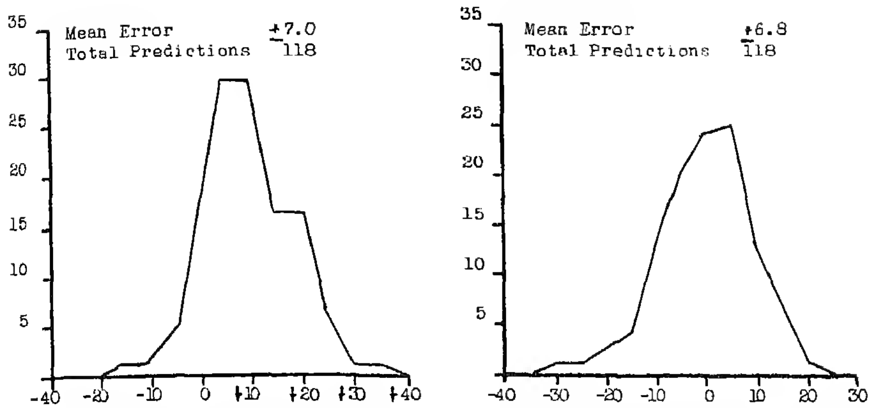


Figure E. Relationship Between I. Q.'s and Girl's Median Time Required for Complete Maturation

Fig. 13. Relationship Between I.Q.'s and Computed Constants in the Reading Equation (Girls).



A. Distribution of Errors in Predicting Individual Intelligence Ratios from the Equation, Reading I. Q. = $\frac{K^1}{K}$ x I. Q.

B. Distribution of Errors in Predicting Individual Intelligence Ratios from the Equation, Reading I. Q. = $\frac{K^1}{K}$ x D. R.

Fig. 14. Distribution of Error in Predicting Individual Intelligence Ratios from Individual Reading Ratios.

an average error or ± 7.0 was found in predicting individual I.Q.'s for all cases (Figure 14A).

Using the developmental ratio of each child corrected for his maximum,

$$\text{Reading I.Q.} = \text{D.R.}^{*} \times \frac{\text{Individual Max.}}{\text{Group Max.}}$$

a ratio, comparable to the I.Q., was determined for each individual which showed a mean deviation of ± 6.8 from the actual I.Q.'s (Figure 14B).

Conclusion: Intelligence was found to be a potent factor not only in determining performance at a given time, but likewise in determining the very character of learning. The bright children were found to begin achievement at an earlier age than the dull children, and consequently to mature earlier. Although intelligence seemed to have no effect upon rate of growth in reading, differences were found to exist in the maxima to be achieved.

APPRAISAL AND IMPLICATIONS

Evaluation of the Growth Technique

In every phase of the study the growth technique proved to be practical and efficient in describing growth in reading achievement. Its value was also demonstrated in analyzing differences in various aspects of growth of comparable groups of children.

*Developmental Ratio was determined from the equation, $D.\ R. = \frac{\text{Time Required by Individual for Complete Maturation } (T_1)}{\text{Time Required for Group for Complete Maturation } (T)}$

In view of present limitations in our concept of growth, the foremost value in the technique lies in its use as an instrument of analysis. Only when sufficient knowledge is derived concerning all phases of growth can the technique realize its maximum potentialities as an instrument of prediction.

One of the greatest criticisms of educational research lies in the fact that results from one section of the country cannot be verified by results from another section. It is the belief of the writer that much of the existing inconsistency will disappear when data are collected and arrayed in terms of growth.

Nature of the Reading Achievement Curve

To the uninitiated the wide variation between the "curves of Constants" and the curve of the Stanford norms (Figure 4) will cause great surprise if not downright consternation. Only by a stretch of the imagination can the line drawn between the Stanford grade norms be called a curve, whereas there is no doubt as to curvilinear character of the "Curve of Constants." The explanation has already been given that the straight-line effect is due to smoothing which involuntarily occurs when the scores of a large number of children are averaged who possess, as is shown in this study, individual characteristics.

A study of the distribution of errors of the predicted scores from the observed scores is enlightening (Figure 3). Were any reader to remain skeptical regarding the curvilinear nature of reading growth, an analysis of the error distribution will prove helpful. The errors are fairly well divided as positive and negative errors. This means that the curves formed by the predicted scores, which form perfect curves, do not all fall above observed performances, thereby producing a majority of positive errors, which would be the case if individual growth followed more nearly a linear than a curvilinear form of development.

Effect of Teaching

It is a well-known fact that reading activities form the base of the curricular program in the first two grades. When a child reaches grades three and four, many other subjects are introduced and the emphasis given to reading activities in the first two grades is considerably lessened. In grades five and six, reading activities utilize even less time, although the pupils employ their knowledge of reading in practically every subject. The point to be made is that in spite of the shift in method used in teaching reading, the curve of achievement follows, from grade to grade, a precise pattern of development. Nor does the achievement curve appear to be significantly affected by the change in teachers which occurs as the child progresses from grade to grade. Case 52M, Figure 15, illustrates this fact. In the instance of this child the obtained test scores show less than ± 2.0 deviation in the child's developmental curve over a period of forty-four months.

Case 50M, Figure 15, illustrates the dismay and consternation brought to the teacher who interprets achievement from one testing to another in terms of the Stanford norm. According to the norms, marvelous improve-

ment is shown between the first two testings. The curve rises sharply, almost perpendicularly. In terms of the norm, the third testing, following an interval of normal teaching activity, shows improvement scarcely up to the amount expected for the time intervening. The teacher becomes upset and feels generally that her efforts have been woefully ineffective. Looking at the curve from the point of view of growth, the interpretation is that the growth made between the second and third testing is equal, per unit of time, to the growth made between the first two testings.

Implications to Educational Diagnosis

From the practical point of view no one can overlook the great contributions which tests and measurements have made to education in general and to the teaching of reading in particular. Everyone interested in educational research is familiar with these, but in order to point out the need for improvements in our diagnostic techniques a review of certain outstanding contributions is pertinent.

Only through educational tests have the existence and importance of individual differences in the capacities of children been made known. Before tests were available, individual interests were ignored, and individual needs were unknown concepts. Subject matter was broken into grade levels, and children were required to read, write, spell, and do arithmetic at a given time, without any consideration being given as to whether words or numbers had any meaning. Educational requirements were entirely standardized, and children consequently mastered essentials in

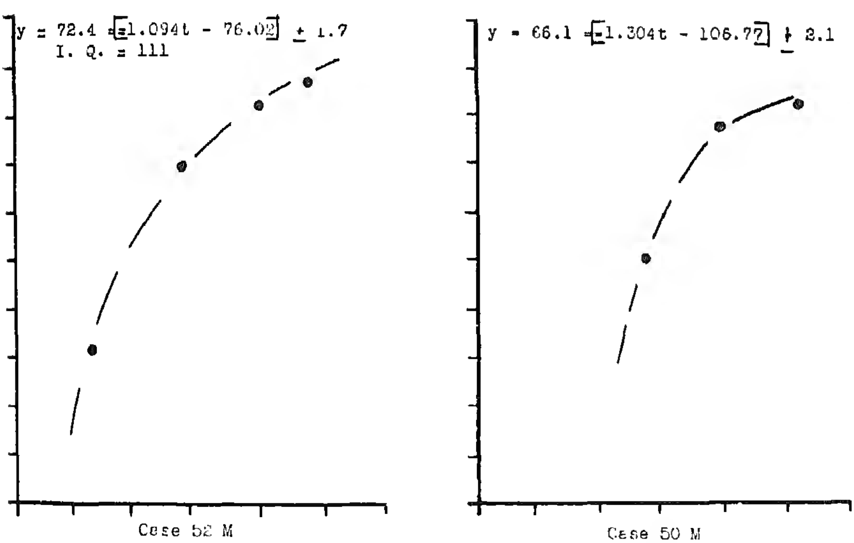


Fig. 15. Cases Illustrating the Regularity of the Growth Pattern Over Extended Age Intervals.

varying degrees of success. When the percentage of mastery achieved by a given child failed to reach a high enough plane, the child was held back and the same dose was repeated.

Educational tests have revealed differences in the children's patterns of development. Teachers have been lead to define their aims more carefully, and to appraise success objectively. Much experimental work has been stimulated which has improved our knowledge of the nature of reading and the best teaching procedures to employ.

The acquisition of skills in reading has become a less painful procedure because of the development of individual techniques in teaching. The amount of time required for practice and for repetition in learning a specific skill has been adapted to individual needs. Special helps and clinical aids are brought into use with those who travel too slowly. Consequently, with the informed teacher, the slower child has been released from the pressure which inevitably threatened his course and undermined his sense of security. These achievements characterize the advance which tests have brought into our educational thinking.

Through ignorance and misuse there is also a dark side to the picture. Many administrators and teachers use tests as instruments for revealing absolute and final truths, when in reality tests are still very imperfect instruments for measuring children's reactions. Likewise, because reading tests have such widespread application, many persons feel that our understanding of reading is approaching its maximum. As a matter of fact, real control in the field of reading has yet to begin.

Differences in the individual reading curves portrayed in this study indicate that educational testing which has done much to show the need for individual teaching techniques must soon put its own house in order. A comparison of the reading development of an individual child with a so-called norm points out the injustice done the child. This study reveals the fact that the only proper basis on which to judge an individual's performance in reading is by comparison with his own growth curve. Consecutive measures furnish the data for comparison. Under the conditions governing his growth as long as actual growth agreee with predicted growth the child is growing normally. When departures are made from the course of predicted growth, the investigator may know that some new influence is active, and consequently may evaluate its effect.

Implications for Curriculum Development

A knowledge of the reading achievement curve and of the technique in evaluating effects probably offers greater opportunities to the curriculum makers than to any other group. Consecutive measures of achievement make it possible to compare the effectiveness of a new program upon achievement through both individual and group analysis. For example, it will be a future possibility to compare the pattern of the development in reading already established with a future pattern produced perhaps under a changed curriculum. A long time program indeed, but one surely more significant and of more import than a thousand of the conventional three-month testing surveys which make comparisons of the averages of large groups with the average of even larger groups.

The implications of this study are many and varied. In the first

place, a study of the individual curves illustrate the fact that children are capable, under constant conditions, of reaching only one natural maximum. Excessive teaching effects can bring only superficial results. The child must live at his own natural age-social level. The well-informed teacher realizes that to stimulate him above this level brings only an unnatural condition. Arriving at a given reading maturity ahead of his interest maturity may make a child outstanding in his skill mechanics, but it will require him to read at a level of interest beyond his natural development, if he is going to utilize his mechanics to the utmost. If he does not exercise his skill at this level, his skill deteriorates. This condition is often found in those schools where a major emphasis is placed upon reading mechanics in the lower elementary grades.

By introducing reading more gradually and at the times when the child realizes a real need or feels the desire to read, the reading curve will naturally follow the child's maturity curve and the status of his achievement at any time will be compatible with his interest and social maturity. Therefore, no excuse need be made for the later introduction of formal reading.

The teacher, informed as to the nature of the reading achievement curve, does not become alarmed because certain pupils progress at slower rates. Pressure is something that should no longer be utilized in enabling teachers to drive pupils toward an unnaturally high standard. With a knowledge of differences of the learning curves of individual children, the teacher may know that a pupil who appears slow at an early grade level may simply be showing the result of a late starting point. It is not unusual to find pupils who, in spite of pressure and assistance on the part of the teacher, have shown scarcely any indication of reading ability up to the end of the second grade. In some instances, without any apparent outside influence, these same pupils begin to read and at the upper elementary grade levels frequently outstrip others who began earlier but progressed at a slower rate of learning. The uninformed teacher is often amazed that children, known to be intelligent, show no permanent benefits from lengthy drill and remedial periods. These teachers have not yet learned that the real growth curve of the individual is but little effected by instruction for which the child is not ready.

There are certain aspects of individual differences which need further investigation. Teachers are too likely to think of individual differences as differences in what is commonly called capacity. As a result of this concept, children are frequently given intelligence tests to determine whether they are yet ready for the introduction of formal reading. Definite mental maturities have been determined as the proper age for the acquisition of certain specific skills. But as the existence of individual differences has been recognized, so must there be a full application of this idea. A norm is only a mythical concept, - a theoretical point of view. Mental ages are determined by comparing an individual child with tho average of "all" children. By this relationship, we attempt to adjust achievement. We have not yet been brought to the realization that individual differences are much more complex than this. A number of children in any first grade may arrive at a given time to a mental age of six years. This is well and good, and for the time being we may conclude that these children are mature enough to begin reading. But a mental age of six years does not necessarily indicate equal poten-

tialities. This, however, is the conventional viewpoint. Cumulative studies show that a child among others with a mental age of six years in the first grade may deviate above or below in the second grade, or h may continue along with the others. Therefore, the primary teacher mus not conclude that a group will progress at equal rates because the grou have, at a given time, reached a mental age of six years.

In the upper elementary grades, a teacher may be disappointed in th progress of a child, as measured by given standard tests. To her disma she may find that in the preceding year marked improvement was made. U doubtedly a graph of the child's reading achievement would indicate natural progress throughout, and the exceptional rise would be found to occur on the early part of the curve. In these upper grades, then, chi dren should not be driven or given excessive drill because they appear to be approaching a standstill. The teacher should study the progress of the child throughout all grades. The evidence of a standstill may b found to be faulty when the scores are treated in terms of growth, and progress may be found to be perfectly normal when so considered.

SUMMARY

The investigation undertaken to determine the character of the pre-adolescent curve in reading achievement resulted in the following conclusions:

1. Regularity of Growth: The equations derived from the observed performances were found to picture the reading development of the entir group within a mean deviation of less than ± 3.0 points from actual measured performances. Approximately one-third of the errors were foun to deviate less than ± 1.0 from observed measures. In view of the conditions which tend to produce unreliable test results, such as unreliability in the test itself, the varying effects of teaching as the child progresses from grade to grade, variation in health, etc., it seems remarkable that individual performances follow such a predictable patterr of development.

2. Sex Differences in Growth: Utilizing the Curves of Constants c unmatched boys and girls, girls' performances were found to be superior to those of boys. Significant differences in the growth patterns favor ing girls were found to exist in the ages at which the groups began and completed their cycles of development.

When allowances were made for differences in intelligence, no signi icant differences were found to exist between boys' and girls' scores.

3. Effect of Intelligence: For both boys and girls, the reading achievements of the groups with the higher I.Q.'s were found to be mark edly superior to those of the groups with lower I.Q.'s.

The more intelligent children, both boys and girls, were found to t growing toward higher maxima, and likewise began and ended the pre-adolescent reading cycle at earlier ages than the children of lower intelligence levels.

Intelligence ratings were predicted from individual reading ratios, which varied less than ± 7.0 from the measured I.Q.[25]

[25] *This amount of variation is equivalent to the deviation found between I.Q. measures for these children.*

4. Comparison of Individual Performance with Stanford Norms: In all instances, wide differences were found to occur between an individual pattern of growth and growth as represented by the Stanford norms. The Curves of Constants (Figure 4) and the individual curves illustrate the fact that growth in reading presents certain curvilinear characteristics which are not comparable with the approximate straight-line norms of the Stanford tests.

The conclusion must be made that the concept of norms needs revision. Evidence such as that shown in this study illustrates the injustice done many children by comparing their performances with so-called norms which so inadequately describe the true nature of growth.

APPENDIX A

Boys' Stanford Scores

in

Reading

Pre-Adolescent Constants

General Isochronic Equation

$$y = K_1 = [= r_1 t + i_1]$$

Equation from Mean Values

$$y = 74.7 = [= 1.123t - 82.20]$$

"b", point taken as beginning of growth

"c", approximate time required for completion of cycle

"t", age at which approximate completion of development occurs

APPENDIX A

BOYS' READING SCORES

PRE-ADOLESCENT CONSTANTS

Case No.	I.Q.	K_1	r_1	b_1	c_1	t_1	Dev.	Age Span	Scores
1m	111	67.6	1.064	64.5	71.5	136.0	±2.4	88-116	6
2m	111	79.4	1.207	69.4	63.0	132.4	±1.9	94-122	6
3m	111	95.5	.745	63.6	101.9	165.5	±2.8	106-134	6
4m	107	85.1	.868	69.7	87.4	136.5	±6.3	99-127	6
5m	86	51.3	1.371	90.7	55.4	146.1	±1.7	110-134	5
7m	90	57.5	.981	70.7	77.3	148.0	±4.8	100-128	6
8m	106	69.2	1.382	81.2	54.9	136.1	±3.2	105-133	6
9m	115	72.4	1.254	66.4	60.6	127.0	±2.2	93-121	6
10m	115	95.5	.844	56.0	90.0	146.0	±2.6	95-123	6
11m	105	74.1	1.198	74.0	63.5	137.5	±5.7	100-128	6
12m	122	75.9	1.391	64.3	80.9	145.2	±2.2	93-122	6
13m	111	63.1	1.485	74.1	51.2	125.3	±3.2	89-117	6
14m	111	72.4	1.413	81.8	53.8	135.6	±3.2	106-122	4
15m	106	60.3	1.170	68.2	65.0	133.2	±3.6	92-120	6
16m	101	72.4	.988	60.0	77.3	137.3	±5.3	94-118	5
17m	115	75.9	1.148	70.0	66.1	136.1	±3.1	96-124	6
18m	112	89.1	1.066	66.8	71.1	137.9	±4.6	99-135	7
19m	106	75.9	.775	55.6	97.9	153.5	±4.4	98-134	7
20m	107	75.9	1.134	75.0	67.1	142.1	±2.1	104-128	5
95m	100	70.8	1.032	66.6	73.8	140.4	±3.8	100-124	4
21m	96	69.2	.970	75.2	78.4	153.6	±2.6	107-143	7
22m	109	79.4	1.021	64.0	74.3	138.3	±3.7	89-123	5
23m	88	46.8	1.124	74.2	67.4	141.6	±3.9	101-133	6
24m	88	57.5	1.227	88.8	61.8	150.6	±2.8	119-139	4
25m	102	66.1	1.191	77.3	63.8	141.1	±2.1	107-135	6
26m	106	75.9	.928	68.8	81.7	150.5	±0.8	110-142	6
27m	106	85.1	1.383	86.0	55.1	141.1	±2.6	114-130	4
28m	119	85.1	1.464	93.5	52.0	145.5	±2.6	121-137	4
30m	107	83.2	.962	61.2	79.0	140.2	±2.8	106-130	5
31m	103	67.6	1.122	82.0	67.9	149.9	±2.7	107-123	3
34m	106	81.3	1.132	71.1	67.0	138.1	±2.8	105-133	6
35m	88	58.9	1.111	85.3	74.2	159.5	±1.7	115-139	5
36m	85	49.0	1.251	84.8	60.7	145.5	±1.2	115-135	4
37m	98	69.2	1.063	81.5	71.5	153.0	±3.9	109-129	4
40m	114	85.1	1.176	71.0	64.2	135.2	±1.5	97-129	4
41m	114	89.1	1.097	65.8	69.2	135.0	±1.8	93-129	5
42m	103	95.5	1.140	80.0	66.5	146.5	±2.9	104-128	4
44m	110	87.1	.854	64.6	88.9	153.5	±2.9	101-137	5
45m	105	70.8	1.349	74.2	56.3	130.5	±1.3	99-123	3
46m	112	85.1	1.038	68.0	73.1	141.1	±2.6	110-134	4
48m	100	74.1	1.098	76.0	69.2	145.2	±3.8	100-136	5
49m	124	95.5	1.040	58.2	73.1	131.3	±4.3	95-119	4
50m	101	66.1	1.304	81.9	59.1	140.0	±2.1	107-131	3
51m	114	83.2	1.390	81.4	54.7	136.1	±1.9	104-136	4
52m	111	72.4	1.094	69.6	69.5	139.1	±1.7	94-126	4
55m	102	72.4	.701	56.0	108.5	164.5	±3.0	97-133	6
60m	97	77.6	.873	64.7	88.9	153.6	±2.3	106-142	5
61m	100	85.1	1.331	81.3	57.1	138.4	±2.6	109-133	3
63m	102	72.4	1.066	71.7	71.2	142.9	±2.5	105-139	3
65m	86	50.1	.989	94.0	76.6	170.6	±2.7	126-142	3
70m	103	81.3	1.464	85.6	52.9	136.5	±0.7	112-136	3
71m	104	74.1	1.334	87.6	56.9	144.5	±3.0	112-136	3
72m	112	87.1	1.003	65.4	76.1	141.5	±4.2	97-133	5
77m	103	75.9	.996	76.0	76.3	152.3	±2.3	121-137	3
80m	101	77.6	1.103	73.2	69.0	142.2	±3.1	109-125	3
Mean	104.8	74.7	1.123	73.2	70.2	143.0	±2.8	103.3-130.2	4.8

APPENDIX B

Girls' Stanford Scores
in
Reading

General Isochronic Equation

$$y = K_1 = [= r_1 t + i_1]$$

Equation from Mean Values

$$y = 75.3 = [= 1.212t - 87.26]$$

"b", point taken as beginning of growth

"c", approximate time required for completion of cycle

"t", age at which approximate completion of development occurs

APPENDIX B

GIRLS' READING SCORES

PRE-ADOLESCENT CONSTANTS

Case No.	I.Q.	K_1	r_1	b_1	c_1	t_1	Dev.	Age Span	Scores
1f	100	63.1	.895	72.6	84.7	157.3	±4.0	106-134	6
2f	127	91.2	1.283	62.6	59.3	121.9	±5.0	84-112	6
3f	107	69.2	1.022	66.2	74.4	140.6	±2.9	100-128	6
4f	113	74.1	1.021	54.8	74.3	129.1	±3.0	90-118	6
5f	112	77.6	1.233	69.8	53.7	123.5	±4.3	94-122	6
6f	95	63.1	1.153	82.0	61.0	143.0	±1.9	109-137	6
7f	90	60.3	1.254	79.9	60.6	140.5	±2.5	109-137	6
8f	117	60.3	1.583	67.5	48.1	115.6	±1.9	94-110	4
9f	103	61.7	1.468	89.0	51.5	140.5	±1.2	119-131	3
10f	120	87.1	1.220	65.8	70.3	136.1	±4.1	95-120	5
11f	81	50.1	.951	77.6	79.9	157.5	±2.8	105-133	6
12f	113	69.2	1.013	62.3	74.9	137.2	±5.3	91-119	5
13f	111	72.4	1.071	69.7	70.9	140.6	±1.4	100-128	6
15f	109	63.1	1.130	62.4	67.2	129.6	±3.0	94-118	5
17f	84	69.2	1.073	85.0	70.8	155.8	±4.0	110-130	4
18f	103	69.2	1.249	71.9	60.8	132.7	±2.4	99-134	7
19f	115	79.4	1.232	65.4	61.7	127.1	±3.5	94-126	6
21f	104	66.1	1.272	67.4	59.7	127.1	±2.7	97-125	6
22f	125	77.6	1.093	49.6	69.2	118.8	±3.1	79-115	7
24f	119	75.9	1.343	59.9	56.6	116.5	±2.6	80-116	7
25f	118	93.3	.858	54.9	98.0	152.9	±5.2	94-130	7
26f	103	81.3	1.060	66.4	71.6	133.0	±4.4	99-119	4
27f	117	75.9	1.106	71.3	69.1	140.4	±2.5	102-118	4
28f	106	100.0	.972	54.6	78.9	133.5	±6.2	86-125	8
29f	102	56.2	1.303	75.3	58.3	133.6	±2.2	102-118	4
31f	102	66.1	1.151	70.8	65.8	136.6	±5.2	98-134	7
32f	105	63.1	1.187	69.7	64.1	133.8	±2.3	100-124	5
33f	89	66.1	1.068	93.5	71.1	164.6	±3.6	120-155	6
34f	96	69.2	1.641	78.8	46.2	125.0	±5.0	102-138	7
35f	118	79.4	.873	59.7	87.0	146.7	±3.8	93-132	8
37f	140	91.2	.995	54.8	84.9	139.7	±1.5	102-118	3
38f	111	75.9	1.190	69.1	63.9	133.0	±1.6	100-135	7
40f	129	100.0	1.611	72.1	47.3	119.4	±1.6	99-123	5
41f	108	81.3	1.125	66.0	67.5	133.5	±3.4	102-130	6
42f	91	57.5	1.186	78.5	64.1	142.6	±4.7	107-143	6
43f	102	67.6	1.735	95.0	43.6	138.6	±3.2	111-147	6
45f	128	100.0	.917	61.2	82.8	144.0	±3.8	104-136	6
48f	94	56.2	1.350	85.0	56.4	141.4	±1.2	114-134	4
49f	109	69.2	1.195	60.0	63.5	123.5	±2.3	98-114	4
50f	117	85.1	1.149	66.8	66.2	133.0	±0.8	111-123	3
51f	93	66.1	1.346	93.0	56.5	149.5	±3.5	123-139	4
52f	105	74.1	.856	70.2	87.7	157.9	±1.6	111-143	6
53f	116	85.1	1.204	77.8	63.2	141.0	±3.6	111-132	5
55f	123	91.2	1.512	79.6	50.4	130.0	±2.1	105-129	5
58f	95	66.1	.993	73.0	76.6	149.6	±3.6	100-136	5
59f	107	63.1	1.248	71.2	60.8	132.0	±2.3	106-126	4
62f	114	72.4	1.322	86.0	57.5	143.5	±1.8	109-133	4
63f	144	100.0	1.534	65.3	49.7	115.0	±2.8	96-120	5
64f	103	69.2	1.244	82.3	61.1	143.4	±1.6	106-138	4
65f	107	75.9	.735	49.1	103.4	152.5	±3.4	90-126	5
68f	108	79.4	1.643	87.8	46.7	134.5	±0.5	110-134	3
69f	110	72.4	1.496	82.0	50.7	132.7	±2.1	107-131	3
70f	109	77.6	1.441	74.1	52.7	126.7	±1.7	98-134	5
71f	106	89.1	1.096	78.0	69.1	147.1	±2.5	112-136	3
74f	114	93.3	1.195	74.9	63.7	138.6	±4.2	103-135	4
76f	115	89.1	1.440	87.7	53.6	141.3	±2.2	114-139	3
77f	114	95.5	1.462	76.1	52.0	128.1	±2.0	99-131	4
78f	104	81.3	1.322	81.1	57.4	138.5	±1.4	109-133	3
80f	100	70.8	1.222	81.0	62.0	143.0	±1.2	109-141	4
82f	109	70.9	.857	60.3	88.7	149.0	±3.4	93-131	3
83f	97	60.5	1.277	77.2	59.7	136.9	±1.5	107-131	3
84f	115	69.2	1.084	83.9	45.2	129.1	±2.0	107-131	3
Mean	109.0	75.3	1.212	72.0	65.0	137.0	±2.8	101.9-129.1	4.9

APPENDIX C

Boys' and Girls'

Individual Reading Achievement Curves

Illustrating

Variability in the Fit

of

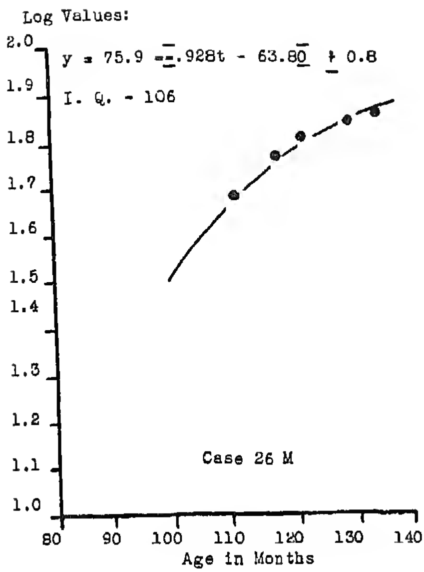
the Various Curves

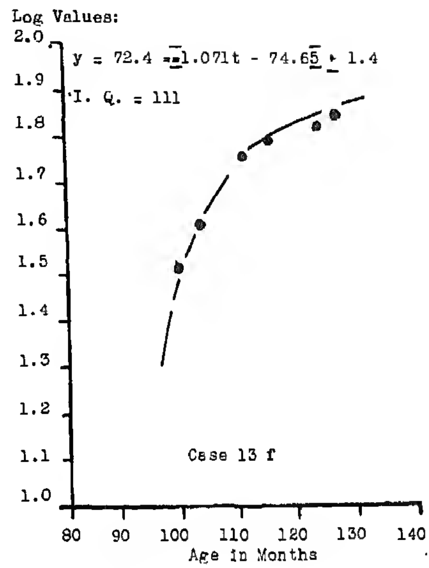
Average Error	Cases
+1.0	26M – 13F
+2.0	2M – 6F
+3.0	13M – 24F
+4.0	22M – 5F
+5.0	7M – 2F
+6.0	4M – 28F

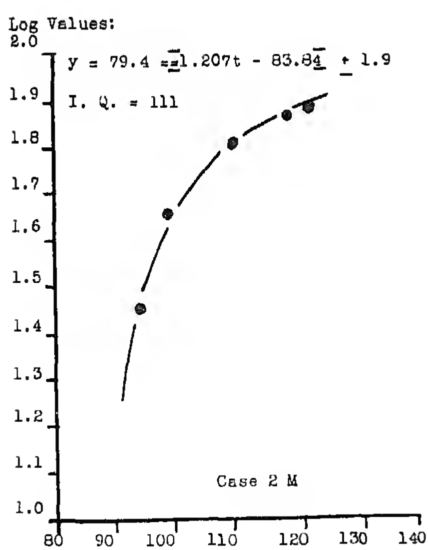
APPENDIX C

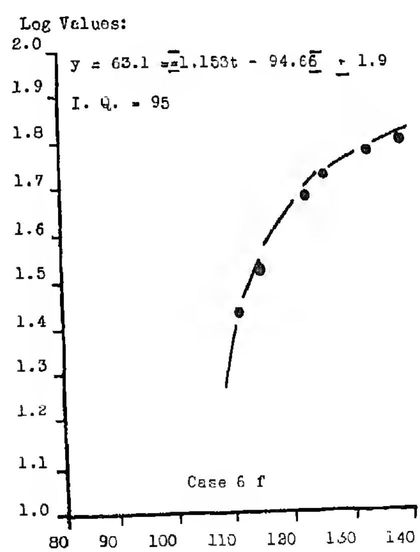
Boys' and Girls'

Individual Reading Achievement Curves

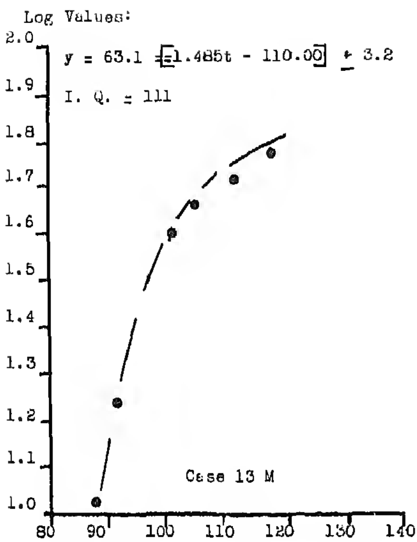


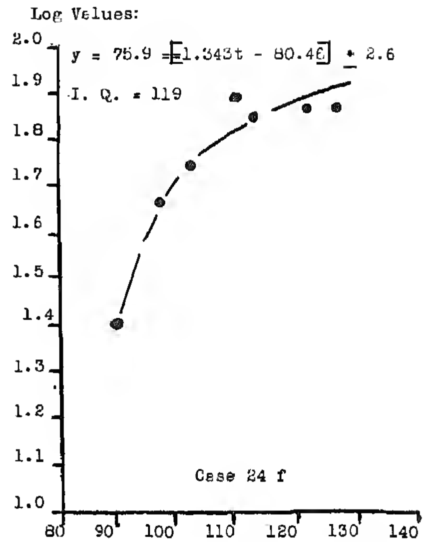


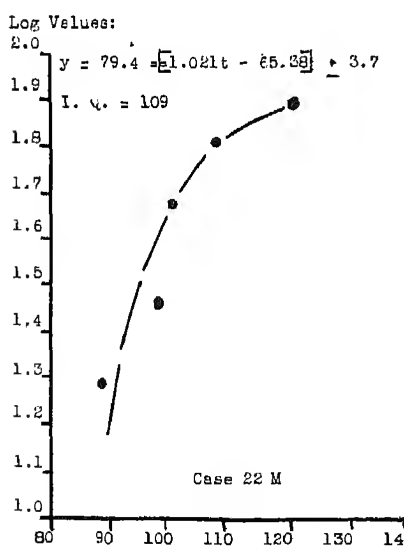


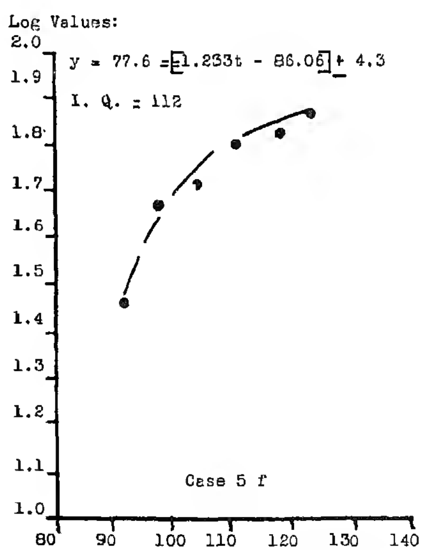


APPENDIX C (Continued)









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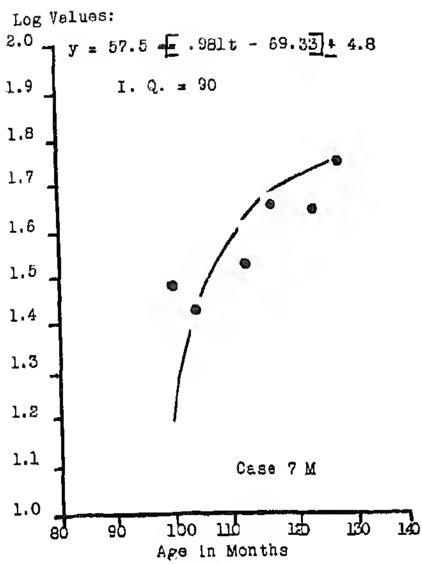

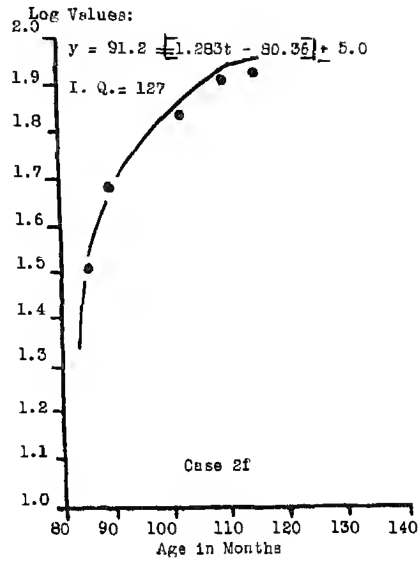

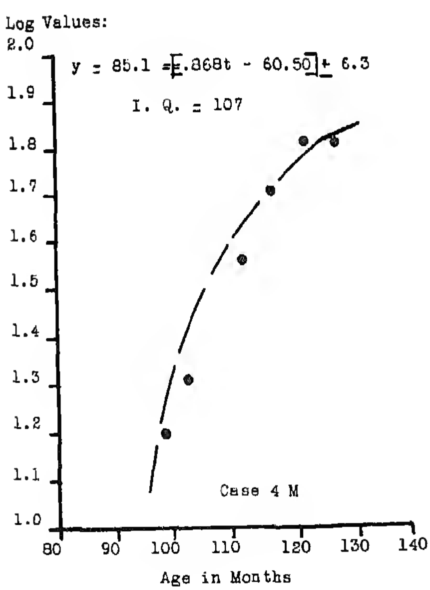

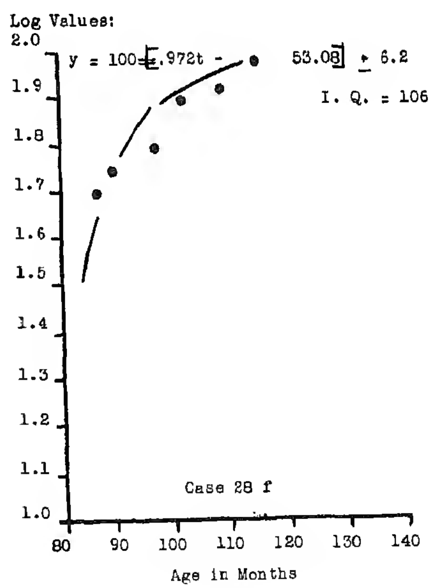

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THE ATTITUDES OF AGGRESSIVE AND SUBMISSIVE BOYS TOWARD ATHLETICS[1]

WILLIAM FAUQUIER

One of the least well understood and probably the most widely discussed subject in the recreational and educational curricula is athletics. Although psychologists and psychiatrists have devoted it little attention, the layman, sportswriter, coach, and physical education teacher have attached to it an inordinate number of generalizations which have little or no experimental basis.

In the first place, the contribution of athletics to the average individual has been grossly exaggerated, too much unwarranted emphasis having been given to the so-called "character value" of competitive sport. In the second place, inadequate research has been directed toward the discovery of how athletics can best serve the vast numbers of dissimilar persons who come to it not only for exercise and recreation, but as part solutions to their mental health problems.

Certainly before athletics can accomplish the many things which enthusiasts claim, something must be known about the differences between individuals and types of individuals in their needs, attitudes toward, and participation in athletic games. For example, are all boys regardless of personality factors, habits, and training interested in the same sports, in the same degree, and for similar reasons? If not, is there a quantitatively measurable difference in this respect between large blocks of similar aged individuals? And, assuming these differences to exist, what are their explanations and implications?

The following study reports an effort to describe quantitatively some of the qualitative differences in attitude toward athletics between aggressive and submissive boys of similar age, intelligence, academic standing, and physical equipment. Attempt is made, first, to illustrate the differences between these groups of boys in the way they utilize athletics for the satisfaction of basic personality needs and, second, to indicate a few of the more obvious relationships between these differences and attitudinal patterns - insofar as these patterns are reflected by overt behavior.

PROCEDURE

Informal observation of institutional boys at play suggested that certain constant differences existed between boys in their habitual choice of games and in the degree of enthusiasm which characterized participation. Preliminary investigation proved that there was a crude correlation between the kinds of games most frequently played and the type of boy, that is, his problems and especially his conduct. Adler, a decade ago, intimated this relationship. "Games are not to be considered," he said, "as haphazard ideas of parents and educators, but they are to be considered as educational aids and as stimuli for the spirit, for the fantasy, and for the life technique of the child. The

[1] *This study was conducted at Berkshire Industrial Farm, Canaan, New York, and read at the 16th Annual Meeting of Upper New York Psychologists, New York State College for Teachers, Albany, New York, April 26, 1940.*

preparation for the future can be seen in every game. The manner in which a child approaches a game, his choice, and the importance which he places upon it, indicate his attitude and relationship to the environment and how he is related to his fellow men. Whether he is hostile or friendly and particularly whether he has the tendency to be a ruler, is evident in his play..." (1, page 91).

Dimock recently stated this another way: "Individuals may find in recreational activities an opportunity to satisfy basic personality needs and urges that are frustrated or inadequately satisfied by other kinds of experience. The particular fundamental drives, or desires, that may find wholesome expression in play activities include: the desire and need for novelty, adventure, and excitement; the deeply rooted necessity of social approval, attention, status, and recognition; the urge for a sense of mastery, power, success, and achievement" (5, page 36).

Proceeding upon these assumptions, the scores of a specially designed athletic questionnaire were compared for three groups of boys classified according to their behavior records.

For comparative purposes a control group of forty adolescents who were making a successful adjustment to their home and school environment were drawn from a New York Junior High School. Darrow and Heath (9) have pointed out that even the most objective attempts to relate one variable of human behavior to another have left us with the question of how much the research has dealt with differences which are fundamental and how much with nonessentials. Special effort therefore has been made to keep the variables discrete, of simple explanation and, what is more, of practical import to the problem at hand.

The carefully recorded conduct of the institutional boys was taken to represent the behavior variable and the qualitative and quantitative scores of these boys on the athletic questionnaire to represent the attitudinal variable; the problem being to compare the differences in attitude toward athletic games between the aggressive and submissive groups of individuals.

The aggressive and submissive groups were composed of 83 delinquent boys from Berkshire Industrial Farm who had been in the institution for twelve months or longer at time of study. A day by day record of misconduct was kept for the whole institutional population, the selected study group being subdivided into 42 aggressive and 41 submissive boys on the basis of conduct. By comparison with the median number of reports for all boys, each individual was classified into either one of the two behavior groups.

Whatever might have been the similarities of the boys in the two institutional groups, they have one distinct dissimilarity: the difference in their conformity to the regulations of the institution over a period of one year. The aggressive boy, compared to the recessive or submissive boy, is one who has refused more frequently to obey, has more often shirked his work and duty, and has offered more overt resistance to the rule of his fellows and staff members.

It should be pointed out that not all of the catagories in Table 1 represent typical agressive behavior. Inattention, for example, is a characteristic withdrawal mechanism and running away and attention getting may not be thought of as being aggressive in the limited sense of the word. But boys having a high general misconduct record similarly

TABLE 1

FORM USED IN THE TABULATION OF REPORTS FOR MISCONDUCT

Name		Conduct Reports by Months											
Admitted	Born	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
AVOIDANCE OF RESPONSIBILITY	breach of routine												
	shirking work or duty												
	missing appointments												
	inattention												
ANTI-SOCIAL BEHAVIOR	stealing												
	lying												
	violence, cruelty												
	destruction of property												
	disobedience to gain end												
INFANTILE BEHAVIOR	runaway												
	temper												
	negative-spite reactions												
	attention getting												
	insolence												
	swearing												
	TOTAL												

show a higher count for such acts as fighting, bullying, stealing, destruction of property and disobedience. The median number of reports for such aggressive acts was 17.5 for the aggressive group and 2.7 for the submissive; the former having a range of 5-83 misconduct reports and the latter from 0-12. This being so, the total number of reports for misconduct was arbitrarily taken as being representative of aggression.

All boys were given a mimeographed copy of the athletic questionnaire during a period of the school day. The questions were read aloud by the examiner and discussed as occasion demanded. Being mostly of the multiple choice variety, the replies required in most instances only a check mark. To insure some measure of reliability the answers to the questions were weighted either 1, 2, or 3 according to the degree of interest they implied. For example, the replies to the first question, "Do You Like Sports?" were weighted in the following manner: <u>very much</u> (3 points); <u>a little</u> (2 points); <u>not at all</u> (1 point). A maximum of 55 points and a minimum of 18 points represented the possible point range. The groups were compared by averages and dispersions for the point scores, and according to percentage differences for each question.

CHARACTERISTICS OF GROUPS STUDIED

For convenience of recording, the institutional-aggressive group will be referred to as I-A; the institutional-submissive group as I-S; and the normal-control group as N-C.

It has been suggested that the height, weight, and age differences between the three groups might be more important than the conduct dissimilarities, and, furthermore, that these factors might possibly account in a large measure for the behavior pecularities of these boys. While this notion is not entirely unfounded, it does not account for the situation in this study. The height and weight factors might conceivably be the basis for greater frustration and aggressiveness of the smaller and younger I-A individuals except for the fact that the institutional boys

TABLE 2

MEDIAN I.Q.,[2] CHRONOLOGICAL AGE, HEIGHT, WEIGHT, AND NUMBER OF REPORTS FOR MISCONDUCT; RANGE IN NUMBER OF REPORTS FOR MISCONDUCT; AND NUMBER OF BOYS IN EACH GROUP

Group	Median I.Q.	Median age	Median height (inches)	Median weight (lbs.)	Median no. of reports for misconduct[3]	Range in no. of reports for misconduct	Number of boys
I-A	93	14-0	61.8	97.8	41.5	22.5 - 151.0	42
I-S	93	15-7	64.1	115.0	10.3	0.0 - 22.5	41
N-C	90	15-4	64.0	117.9	-	- -	40

always compete in their own age and size divisions and could hardly be aggressive because of competition with older and stronger opponents. As regards the age difference, it is admitted that developmental factors surely contribute something toward the explanation of interest and activity differences between older and younger boys. These differences are, however, probably unimportant in the lives of institutional boys where athletics is given equal stress and assumes equal importance as a recreational factor for individuals of all ages.

The data of Table 4 indicate a reliable difference between the mean scores of the I-A and I-S groups. In this instance the probable error

TABLE 3

MEANS AND STANDARD DEVIATIONS FOR POINT SCORES ON ATHLETIC QUESTIONNAIRE FOR FOUR GROUPS[4]

Group	Mean Score	Standard Deviation
N-C	44.72 ± .44	4.68
I-G	46.66 ± .42	5.73
I-A	49.00 ± .40	3.93
I-S	43.22 ± .59	5.61

TABLE 4

PROBABLE ERRORS BETWEEN THE MEAN SCORES OF THE FOUR GROUPS

Group	Institutional Group		Institutional-Submissive		Institutional-Aggressive	
	Difference between means	Probability of a deviation beyond $\frac{x}{P.E.}$	Difference between means	Probability of a deviation beyond $\frac{x}{P.E.}$	Difference between means	Probability of a deviation beyond $\frac{x}{P.E.}$
N-C	1.42 ± 1.69	.3292	1.50 ± 1.51	.3056	4.28 ± 1.41	.0317
I-G			2.92 ± 1.61	.1626	2.86 ± 1.49	.1476
I-S					5.78 ± 1.35	.0026
I-A						

[2] *The Revised Stanford-Binet Scales L and M were used exclusively as the mental test criterion for the institutional groups. The Henmon-Nelson Tests of Mental Ability were used for the normal-control groups.*

[3] *The normal-control group coming from a public high school situation offered no objective conduct measure such as was available for the institutional groups.*

[4] *In Tables 3 and 4 the aggressive and submissive groups were combined to form a fourth group - the whole institutional group as represented by the symbols I-G.*

of the difference is 4.28.[5] With this in mind the following tables are offered with the intention of showing the possible dissimilarities in athletic attitude and participation between the institutional-aggressive and institutional-submissive boys. Although the differences between the point scores are reliable, the dissimilarities for any one question as set forth in the following percentage tables may be largely the function of chance. The mean of the normal-control group closely resembles that of the institutional-aggressive and institutional-submissive groups combined. This being so, its point-to-point similarity to or difference from these two groups is interesting and shows where either group approaches or diverges radically from what may be thought of as normal.

In the following tables the particular question of the athletic questionnaire is contained verbatim in the title whenever possible. When the question is not stated verbatim, the title is self-explanatory.

TABLE 5

RESPONSES TO THE QUESTION, "DO YOU LIKE SPORTS?"

Group	Attitude toward sports					
	Like sports very much		Like sports a little		Do not like sports at all	
	N	%	N	%	N	%
I-A	35	83.3	5	11.9	2	4.8
I-S	32	78.1	9	21.9	0	0.0
N-C	34	85.0	5	12.5	1	2.5

This question was not particularly differential. For all purposes the three groups show an almost identical interest in sports. The data in Table 6 are more discriminating.

TABLE 6

RESPONSES TO THE QUESTION, "CHECK THE TYPE OF GAMES WHICH YOU LIKE BEST"[6]

Group	Team Games		Individual Games	
	Number	%	Number	%
I-A	35	83.3	7	16.7
I-S	28	68.3	13	31.7
N-C	37	92.5	3	7.5

The I-S boys prefer individual to group games. The choices of the I-A and N-C boys indicate that they are more interested in group games. Table 7 corroborates this notion.

Among the first six choices which include about 75 per cent of all responses, the boys of the I-S group list swimming, skating, and hiking - all individual sports. Those of the other two groups indicate only swimming. If all sports be classified into either group or individual

[5] *A difference or a statistical constant of any sort is not significant unless it is at least four times its probable error.*

[6] *Two choices were given: 1) Games played alone like tennis, handball, hiking, and skiing; 2) games played as a member of a team like football, basketball, and hockey.*

TABLE 7

RESPONSES TO A QUESTION ASKING THE BOYS TO CHECK THEIR FAVORITE GAME BY PLACING A ONE IN FRONT OF THE GAME THEY LIKED BEST, A TWO IN FRONT OF THE GAME SECOND BEST, A THREE IN FRONT OF THE GAME LIKED NEXT BEST, ETC.[7]

Favorite Games					
I-A Group		I-S Group		N-C Group	
Football	20.7%	Swimming	16.3%	Basketball	23.2%
Basketball	14.9	Basketball	15.5	Baseball	18.4
Baseball	13.6	Football	12.8	Swimming	14.4
Swimming	11.1	Skating	8.8	Football	13.7
Track	9.5	Hiking	8.1	Hockey	6.1
Hockey	6.2	Baseball	8.6	Skating	5.3
Skating	5.5	Tennis	5.8	Track	4.3
Hiking	3.5	Hockey	3.9	Hiking	2.6
Skiing	3.5	Track	2.7	Ping-pong	2.5
Ping-pong	2.2	Ping-pong	2.6	Sledding	2.1
Others	8.4	Others	14.9	Others	7.4
Total	99.1		100.0		100.0

games regardless of the competitive factor, 42.3 per cent of the I-S boys choose individual games compared to 35.2 per cent of the I-A and 31.2 of the N-C group boys. The parity here between the N-C and the I-A groups is very close, and strictly in accordance with the preferences shown in Table 6.

Can the I-S boys' dislike of competitive group games be explained in terms of their greater insecurity and feelings of inferiority? Tables 8, 9, 10 and 11 seem explanatory.

The data of the following four tables seem to verify the notion that the game choices of the I-S boys reflect their greater inferiority, frustration, nervous tension, and insecurity. In every instance this group admits greater inadequacy, anxiety, and sense of failure. There is in these instances a close correspondence between the attitudes of the I-A and N-C groups, the I-S group apparently being divergent from normalcy in these respects.

TABLE 8

RESPONSES TO THE QUESTION, "DOES PLAYING GAMES EVER MAKE YOU FEEL BADLY AS THOUGH YOU WERE NOT AS GOOD AS OTHER BOYS?"

Group	Degree of Inferiority Felt in Playing Competitive Games					
	A Great Deal		A Little		None at all	
	Number	%	Number	%	Number	%
I-A	4	9.5	17	40.5	21	50.0
I-S	1	2.4	28	68.3	12	29.3
N-C	0	0.0	24	60.0	16	40.0

[7] *Five points was awarded for first choice, four points for second choice, etc. In this way a point scale of popularity was obtained. The percentages of Table 7 were obtained by dividing the total number of points cast for each sport by the total number cast for all sports.*

TABLE 9

RESPONSES TO THE QUESTION, "DOES IT MAKE YOU ANGRY TO LOSE IN SPORTS OR GAMES?"

Group	Frequency of Anger Felt Through Defeat in Games					
	Often Felt		Sometimes Felt		Never Felt	
	Number	%	Number	%	Number	%
I-A	0	0.0	28	66.7	14	33.3
I-S	0	0.0	34	83.0	7	17.0
N-C	1	2.5	24	60.0	15	37.5

TABLE 10

RESPONSES TO THE QUESTION, "DOES IT MAKE YOU NERVOUS WHEN SOMEONE IS BEATING YOU IN A GAME?"

Group	Emotional Experience When Losing in a Game					
	Very Nervous		A Little Nervous		Not Nervous	
	Number	%	Number	%	Number	%
I-A	8	19.1	11	26.2	23	54.8
I-S	5	12.2	20	48.8	16	39.0
N-C	3	7.5	10	25.0	27	67.5

TABLE 11

RESPONSES TO THE QUESTION, "DO YOU LIKE TO PLAY AGAINST STRANGERS?"

Group	Attitude Toward Playing Against Strangers					
	Dislike to Play Against Strangers		Dislike a Little to Play Against Strangers		Like to Play Against Strangers	
	Number	%	Number	%	Number	%
I-A	4	9.5	8	19.1	30	71.4
I-S	5	12.2	9	21.9	27	65.9
N-C	4	10.0	6	15.0	30	75.0

As a further check on athletic attitudes and preferences, the data of Tables 12 and 13 reinforce the belief that the I-S individuals do not consider athletics as the best means of satisfying their needs.

The I-S boys admit relatively lesser physical prowess in athletics than the I-A and N-C individuals. The I-A boys rate themselves as being better than average most frequently. The I-S group also looks upon athletics with less enthusiasm than the others. Basically this latter group are more withdrawn and seem less inclined to competitive activities and show a proclivity to pursue hobbies which are as a rule individualistic in nature. When they do enter into competitive athletics, their attitudes toward success are different than those of the I-A boys. Table 14 is further illustrative.

The boys of the I-A group voice a relatively stronger bent for success

TABLE 12

RESPONSES TO A QUESTION ASKING THE BOYS TO RATE THEMSELVES AS ATHLETES

Group	Self Rating as an Athlete					
	Better than Average		Average		Worse than Average	
	Number	%	Number	%	Number	%
I-A	11	26.2	14	33.3	17	40.5
I-S	3	7.3	16	39.0	22	53.7
N-C	4	10.0	16	40.0	20	50.0

TABLE 13

RESPONSES TO THE QUESTION, "WHAT IS YOUR FAVORITE HOBBY?"

Hobby	Numbers and Percentages Shown by Groups					
	I-A Group		I-S Group		N-C Group	
	Number	%	Number	%	Number	%
Athletics	16	41.0	10	25.0	14	40.0
Collecting	6	15.4	4	10.0	4	11.4
Cooking	5	12.8	2	5.0	0	0.0
Model Making	4	10.3	4	10.0	1	2.9
Travel	1	2.6	3	7.5	0	0.0
Hunting	0	0.0	0	0.0	3	8.6
Others	7	18.0	17	42.5	13	37.1
Totals[8]	39	100.1	40	100.0	35	100.0

TABLE 14

RESPONSES TO A QUESTION ASKING THE BOYS TO CHECK A SENTENCE BEST ILLUSTRATIVE OF THEIR ATTITUDE TOWARD PLAYING OR WINNING IN A GAME

Group	Attitude Toward Winning in Competitive Games					
	Would Try Anything to Win		Would Try Anything but Cheating		Playing Only is Important	
	Number	%	Number	%	Number	%
I-A	2	4.8	28	66.6	12	28.6
I-S	0	0.0	24	58.6	17	41.5
N-C	0	0.0	18	45.0	22	55.0

than the I-S and N-C boys. On the other hand the typical I-S individual indicates more concern about winning than the N-C boys who profess substantially more mature interest in mere participation regardless of success. These dissimilarities are demonstrated in another way in Table 15.

While the data of Table 15 show a general agreement between the groups that "playing harder" is the best solution to being cheated, the attitudes of the I-A boys suggest a greater aggressive tendency in this situation

[8] *Some boys professed to have no hobby.*

and a greater proclivity to fight and argue. As might have been anticipated, the I-S boys admit a greater inclination to withdraw and significantly lesser tendency to fight or argue. Although the small differences shown in these data probably owe their occurrences to sampling errors, they are related closely to the trends shown in the previous tables.

The importance of athletic prestige is brought out in Table 16. Although there is little disagreement between the two institutional groups, the contrast with the N-C boys is interesting.

Despite a professed slighter interest in athletics, the I-S boys show a stronger identification with athletically gifted companions. The value placed upon this type of attachment by the N-C boys is significantly less.

The data in Table 17 illustrate the institutional boys' significantly

TABLE 15

RESPONSES TO A QUESTION INQUIRING ABOUT THE REACTIONS OF THE BOYS TO A SITUATION IN WHICH THEY WERE BEING CHEATED BY THEIR OPPONENTS IN A COMPETITIVE GAME

Group	Reaction When Being Cheated by Opponents									
	Cheat Yourself		Play Harder		Argue with Referee		Stop Playing		Start a Fight	
	N	%	N	%	N	%	N	%	N	%
I-A	1	2.4	29	69.1	4	9.5	3	7.1	5	11.9
I-S	0	0.0	33	80.5	2	4.9	5	12.2	1	2.4
N-C	2	5.0	31	77.5	5	12.9	0	0.0	2	5.0

TABLE 16

RESPONSES TO THE QUESTION, "THINK OF YOUR BEST PAL. WOULD YOU LIKE HIM WHETHER HE WAS AN ATHLETE OR NOT?"

Group	Attitude Toward Friend If He Were Not an Athlete			
	Would Still Like Him		Would Not Like Him as Much	
	Number	%	Number	%
I-A	32	76.2	10	23.8
I-S	29	70.7	12	29.3
N-C	34	85.0	6	15.0

TABLE 17

RESPONSES TO THE QUESTION, "DO YOU DISLIKE SPORTS IN WHICH YOU HAVE TO RUB AGAINST OR BE IN CLOSE PHYSICAL CONTACT WITH OTHER BOYS?"

Group	Attitude Toward Physical Contact with Other Boys					
	Dislike Very Much		Dislike a Little		Do Not Dislike	
	Number	%	Number	%	Number	%
I-A	4	9.5	11	26.2	27	64.3
I-S	5	12.2	13	31.7	23	56.1
N-C	7	17.5	22	55.0	11	27.5

greater unconcern about being in close bodily contact or to what Freud has called "rubbing games." The normal control boys seem to have already changed more completely to general heterosexual standards and voice a strong conscious dislike for close physical contact with members of their own sex.

TABLE 18

RESPONSES TO THE QUESTION, "DO YOU LOOK UP TO A GREAT ATHLETE LIKE JACK DEMPSY OR BABE RUTH?"

Group	Amount of Admiration for Famous Athlete					
	Very Much		A Little		None at All	
	Number	%	Number	%	Number	%
I-A	22	52.4	9	21.4	11	26.2
I-S	22	53.6	14	34.2	5	12.2
N-C	21	52.2	11	27.5	8	20.0

SUMMARY DISCUSSION

A reliable statistical difference between the means of the point scores of aggressive and submissive institutional boys on an athletic questionnaire has been shown to exist. This difference corroborates the notion that play habits are not isolated and disconnected factors in a boy's personality which may be moulded or remoulded at will, but that they are symptoms reflective of larger and more complicated systems of thinking, feeling, and acting which have the most intimate affective connections with the highly elaborated tissue-needs of the individual. This is to say that a boy who cheats, argues, fights, cries, or withdraws in athletic games cannot be changed into a well-adjusted individual, as many wish to believe, simply by discipline or exemplary leadership on the athletic field.

The aggressive boys seem to carry over into athletics many of their characteristic behavior tendencies or patterns. Their attitudes suggest that they prefer competitive group athletics which satisfy their hyperactive and dominance seeking natures. Basically they seem more interested in winning, less nervous, and less easily discouraged. They rate themselves more favorably as athletes and exhibit a stronger tendency to argue and fight when frustrated. In a previous study in which substantially the same three groups of subjects were used, the aggressive boys[9] showed a surprisingly greater propensity for violent overt reaction than was the case of the boys in the other two groups (7, p. 234).

Contrasted with the aggressive group, the submissive boys voice more interest in noncompetitive, individually played games. They pretend less drive to win, admit greater nervousness, anger, and feelings of inadequacy and seem to have slightly stronger identifications with famous athletes and athletically gifted companions.

The attitudes of the normal control group varied, at one point being similar to the attitudes of the aggressive boys and at another appearing to have more in common with the submissive boys.

[9] *They were referred to as institutionally-maladjusted rather than as aggressive in this study.*

The percentage differences set forth in the data of the various tables may owe their occurrences to sampling errors; but if these differences are largely functions of chance, how can the internal consistency of the data be explained? Nevertheless, this summary must be thought of as being based on what appears to be consistent rather than reliably demonstrated trends.

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HEALTH AND DEVELOPMENT OF A GROUP OF NURSERY SCHOOL CHILDREN

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The advantages of standards of physical and mental growth, whereby individual children may be rated against the norms established by a group, have been fully stated. Within the wide scope of new studies in child behavior, the teacher and parent must always return to the physiological limits within which children are functioning. It is valuable to know not only the central tendencies of groups, but also how wide are the fluctuations which may be expected.

The studies reported here of two to three-year old children are not extensive in the number of subjects, but they offer intensive treatment and introduce details for comparison which are not often included. The various measures of health and development are all for the same subjects. Too often a confusing view of children may be gained by putting together the results of studies with different groups such as the feet of one group, the eyes of another, the sleep of another and perhaps the eating behavior of a fourth.

This is a description of 66 healthy nursery school children on ordinary home regimes, enrolled in the junior nursery school of the New York State College of Home Economics at Cornell University during the five years, 1932-37. Instead of brief samples taken for a week or two at different times of year, happenings of nearly every day were recorded throughout the period during which each child was enrolled. Over 13,000 days of these nursery school children were analysed, with about half of these days at home and half, spent at nursery school.

In addition to the study of the histories of infancy and physical examinations, the events for each day during the school year were coded into numbers and punched into cards which were sorted on Hollerith machines. The information included sleep, eating and nervous behavior at the noon meal in the nursery school, bowel movements, enuresis, outdoor play time, along with facts about the weather, season of the year and other details. This made it possible to determine what children of this age level usually do and how they vary from these norms at different times of year and under changing weather conditions. It was also possible to compare the regimes and development of different types of children such as "good" eaters in contrast to "poor", over-weight children versus under-weight, those susceptible to colds with those resistant. The results of these comparisons are being published elsewhere (6), (7), (8).

During the course of the study, most of the staff members were the same. In addition, nursery school procedures were comparable.

These 66 children, 12 to 15 per year, really constitute five different samples drawn from the community. While they do not represent children at large, it is fair to assume that they are representative of those from professional groups, fortunate for the most part in their homes and health regimes.

The age range was left wide in order to utilize the data of all the junior children during the eight months of the school year. The median

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CHILD DEVELOPMENT, Vol. 11, No. 2 (June, 1940)

age at beginning school was 2 years 7 months. The middle 50 per cent fell between 2 years 4 months and 2 years 10 months, with the youngest child of the group 1 year 11 months and the oldest, 3 years 3 months. The median ages of the boys and the girls were the same and likewise the limits for the middle 50 per cent of boys and girls. There were 31 girls in the group and 35 boys.

In order to give a view of what nursery school children within this age range are like, the data whenever possible were put into three measures; the median to describe the central tendency of the group; the interquartile range or the limits of the middle 50 per cent of the children, showing how closely they cluster about the median and the width of the average range; and finally the total range to indicate how far apparently normal children may be from the median and to mark the outer boundaries of the group.

When single scores per child were given, such as percentage of hemoglobin or weight at beginning school, the median represents the mid-point of these single determinations. But when each child had a number of scores such as hours of sleep per night for about 200 nights, the medians and interquartile ranges were gained from averaging similar points in the distributions of all the children. In this way, the average range in behavior could be learned.

INFANT DEVELOPMENT

Infant histories were taken by the pediatrician from the mothers at the beginning of nursery school.

Age of Parents

The median age of the mothers at birth of these children was 30 years, ranging from the youngest, 22 years of age to the oldest, 41. The middle half of the mothers fell between the ages of 25.5 and 34 years.

The median age of the fathers was 33, with the interquartile range between 28 and 37 years and the total range between 23 and 49 years. When these medians are compared to the latest figures on the average age of fathers and mothers in upstate New York (5), we find the average age of fathers of babies born alive was 31.67 years, and of mothers, 27.49. So in comparison to the general population in this section, the parents of these children were about two years older.

Birth Weights

The median birth weight reported by the mothers was 7.56 pounds for the group with the mid-point for the girls at 7.38 and the boys 7.63 pounds. These weights may be compared to the birth weights gained from a study in Broome County, New York for the months of April, 1939, to December, 1939 (5). This showed the average weight of 2,402 males at birth as 7.47 pounds, and of 2,313 females as 7.15 pounds. By comparison the nursery school children started life as heavier babies.

Feeding and Development

The length of breast feeding for these children ranged from none at all to ten months, with a median of 1 1/4 months for the group. This

was considerably less than the mean of 3 1/2 months which Bizal (2) reported in her study of 657 babies in villages of New York state. While 12 per cent of Bizal's children had never been breast fed at all, 25 per cent of the nursery school children were never breast fed.

Most of the children had supplementary foods added to their formulas early such as cod liver oil or a substitute, orange juice and egg yolk. Cereal was started at 4 or 5 months in most cases. Strained vegetables and fruits were added about this time.

Few food idiosyncracies of infancy were reported except for three children who were said to be sensitive to egg.

Infant schedules of feeding and sleeping were reported as regular in nearly every case, often with sun baths and daily outdoor airing.

The median age of the first tooth was at 6 3/4 months, which is somewhat earlier than 7.5 months reported by Bizal (2). The middle fifty per cent of the children had their first teeth between 5 and 9 months. However, one mother reported a tooth as early as 3 1/2 months and another as late as 13 months.

The median age of first walking was 14 months, later than the mean for Bizal's children which was 12.7 months. Fifty per cent walked between 12 and 15 months. The earliest reported was 9 months and the latest 18 months.

Few early diseases were reported. One-third of the group had had no sicknesses up to the time of nursery school. Five had had whooping cough; 9, measles; 5, tonsillitis; 1, mumps; and 3, chicken pox. Several had had digestive difficulties and complications from colds.

In immunization, practically all had had toxin-antitoxin or toxoid for diptheria, and smallpox vaccinations.

The histories revealed that 21 or practically one-third of the group had sucked their thumbs.

Early operations included 5 with tonsils removed; 2, adenoids; 3 circumcision and 1 operation for harelip.

STATUS AT BEGINNING NURSERY SCHOOL

Physical Development

Weight. On entrance to nursery school at the median age of 2 years, 7 months, the physical examination of the children revealed that the median weight for the girls was 31.38 pounds and for the boys, 33.19. The total range for the group was from 26.69 pounds for the smallest girl, up to 42.0 for the heaviest boy. The norms of Peatman and Higgons (10) of children receiving "a relatively optimal degree of private pediatric care and home supervision," gave for girls, 29.5 pounds and for boys 31.4, at 30 months of age. The nursery school children were heavier than these favored subjects.

Height. In height, the median for the total group was 37.1 inches, with the median for the girls, 36.6 and for the boys 37.3. Peatman and Higgons found that their children at 30 months were 35.8 inches tall for girls, and 36.3 inches for boys. In height also, the nursery school children appeared superior.

Percentage Over or Under Weight and Height. Compared to the averages given by the New York State Department of Health, the median child of the

group was 6 per cent over weight for his height and age. Of course it must be recognized that comparison to such averages yields but crude measures which do not take into consideration differences of body build. The middle fifty per cent of the children ranged from 1 to 11 per cent over weight with a total range from 22 per cent over weight to 9 per cent under weight. Though the medians for the boys and girls were the same, the ranges for the middle fifty per cent in each group show that the girls tended to be more over weight than the boys.

Compared to the state averages for height, the median child was 5 per cent over height for his age. The middle fifty per cent of the children were from 2 to 8 per cent over height with the shortest but 2 per cent less than the state average and the tallest, 13 per cent over height. The distributions for the boys and girls were similar to those of the group with a tendency shown for the boys to be somewhat taller for their ages than the girls.

Weight-Height Index. The median weight-height index for the group, that is the weight in pounds divided by the height in inches, was .88. There was little variation between the sexes. The middle fifty per cent of the children had indexes ranging between .82 and .93. Standards of the children at Merrill-Palmer (16) at 31 months gave the girls an index of .833 and the boys, .855. In comparison, the nursery school children at Cornell appear well developed as a group.

Rate of Growth Since Birth. To discover how rapidly the children had been growing before coming to nursery school, the birth weights were subtracted from the weights at beginning school and divided by the age in months. Thus the median gain per month since birth for the group was .78 pounds, or roughly 3/4 of a pound, with the middle fifty per cent of the children having gained between .70 and .86 pounds per month. The slowest growing of the group had gained but .63 pounds per month versus the fastest who had gained 1.05 pounds per month. It is recognized that this rate of gain had not been steady and even, but it offered a means of roughly separating the children according to this factor. These figures showed little variation for the sexes, although there were more boys in the high 25 percentiles than girls.

Muscular Development. Muscular development was subjectively rated by the pediatrician on a scale of four pluses. One plus was accorded very poor musculature; two, a low average; three, good; and four was reserved for unusually fine development. The group was almost equally divided between the three and two plus scores, leaving only 4 with the four-plus rating of excellent and only 3 with the one plus rating of very poor musculature.

Tissue Tone. The ratings for this characteristic were similar to those for muscular development. Seven children were given four pluses; two children, one plus; and the rest were divided almost equally between two and three pluses.

Posture. Forty-seven or 71 per cent of the children had straight backs, 10 showed exaggeration of the lumbar curve, and 6 were drooping.

Shoulders were usually even, but 28 children or 44 per cent had winged shoulders.

Chests were erect.

Thirty-two of the children or almost half had prominent or slightly prominent abdomens.

Most of the children had straight legs, but 22 or a third had knock-knees of one or both legs and 7 showed bowing of the tibia.

Feet were usually straight, but 23, or a third, revealed pronation of one or both feet, some slight and others marked. This was less than was found in the group studied by Bloxsom (3) who noted among 154 children between two and four years of age, 45 to 50 per cent of the arches were in a developing or not developed state.

Skin. The skin of 19 children, or 29 per cent, showed evidences of eczema or patches of roughened skin.

Eyes. The eyes of 17 children, or 26 per cent, showed at least occasional strabismus of one or both eyes.

Tonsils. Tonsils of six of the children had been removed. Ten others showed signs of infection. This would give 16 cases of infection or 24 per cent of the group.

Teeth. The average number of teeth was 19, ranging from 16 to 20. Possibly as a result of superior home environment and care, repeated examinations showed the teeth clean and without cavities. This contrasts to the report of Pyle and Drain (11) who examined children from the Iowa Child Welfare Station. They found among the three-year-old children, 0.91 cavities per child among the boys and 0.65 cavities per child among the girls. And the percentage at this age level having defective teeth was 23.5 for the boys and 24.5 among the girls.

Lungs and Heart. Lungs and hearts of all the children were normal.

Umbilicus. Five children had small hernias. Five others had hernias that were fairly prominent.

Blood Analysis. In the fall, 22 children, or one-third, had hemoglobin below 80 per cent.[2] The median hemoglobin for the group was 81, with an interquartile range of 76 to 88 per cent and a total range of 70 to 92. The median blood count was 4,290,000 red cells.

Urinalysis. Tests for sugar were positive for 12 children, or 18 per cent of the group, at the beginning or sometime during the year, with repeated tests proving negative. In the experience of the authors, positive tests for sugar are fairly common among children of this age. Tests for albumen were given for only two of the children.

Mental Development

The first Merrill-Palmer tests given by the psychological examiner revealed the median score to be an I.Q. of 113. The interquartile range was 106 to 125 with a total range of 82 to 153. Studies now in preparation, covering a ten year span, also give 113 as the mean I.Q. for the initial Merrill-Palmer tests in the nursery school.

DEVELOPMENT DURING SCHOOL YEAR

Physical Growth

Average Gain in Weight. It was impossible to compare total gains in weight for the year because of different lengths of time the children were enrolled. Therefore the rate of gain was computed by dividing the total gain by the number of weeks between the first and last weighings of the year. The median gain in weight per week for the group was 1.90

[2] *The Dare hemoglobinometer was used.*

ounces. For the girls it was 2.00 and for the boys 1.84. The total range for the group was from 1 to 5 ounces per week.

Average Gain in Height. Likewise the average gain in height per month was computed. Here the median was .25 for the group and for both boys and girls, with a total range of .03 to .40 inches per month.

Mean Deviation in Weight per Week. Again it is recognized that gains are not steady but rhythmical. How much children may be expected to vary from week to week in their weight gains is of interest. The deviations from the mean were computed and averaged for each child. The median for the group was 2.93 ounces with a total range of from 1.73 ounces to 5.11 deviation from the mean per week.

Eating Behavior

Measures. Records of the noon meal at nursery school were kept by the teacher at each table for each child. These included how long the child spent eating his meal; how much of each food was consumed and the order in which different foods were eaten. The total amount consumed was computed in arbitrary units, roughly equivalent to 20 calories.

To know the relationship between the amount a child ate and how long it took him, an efficiency score was determined by subtracting the time in minutes from 100 and to the result adding the number of units. A discussion of eating efficiency and its interpretation has already been made (6), (7), (8), (15).

The norms for this group of children show that the median time required for the nursery school meal was 45 minutes with the middle fifty per cent of the meals ranging from 37 to 55 minutes and a total range of 10 minutes to 89. Though this time is longer than has been reported by other nursery schools, it may be partially explained by the method of table service which allowed the children to help themselves to second servings, to remove their dishes from the table, and perhaps more independence in eating and more social participation.

The median number of units eaten was 25 with an interquartile range of 21 to 30 and a total range of 3 to 49 and more. The median amount would be approximately equivalent to 500 calories for the meal.

The eating efficiency scores, computed as described, ranged from 30 to 100 and more, with an interquartile range of 71 to 90 and a median of 81.

Selection of Foods. Preferences of the children were indicated by the order in which foods were eaten and the amount of second servings to which they helped themselves. The median for eating breadstuffs and protein foods fell at second place. With potatoes and vegetables it was third. This seems to show that the children were relatively more consistent in their second and third choices than in first and last, and that breadstuffs and protein foods were more popular than potatoes and vegetables. Space for milk was not included on the cards, but the impression of the observer was that it was often among the last choices.

The plan for serving the meal was for one tablespoon of each food and one sandwich to be served each child by the teacher. When this first dinner was eaten, the child served himself to second helpings. Five tablespoons of dessert were given for first servings and children could then help themselves to more. The median amounts taken were 2 sandwiches,

2 1/3 tablespoons of protein food, 2 1/2 tablespoons of vegetables and 3 tablespoons of potatoes. Two and one-half tablespoons of dessert were the median second serving. Thus servings for the total meal included the median amounts: 3 1/3 tablespoons of protein food, 3 1/2 tablespoons of vegetables, 4 tablespoons of potatoes, 3 sandwiches, 1 cup milk and 7 1/2 tablespoons of dessert. The children averaged from 3 to 11 per cent of the time when they took no seconds of the dinner foods, and as high as 40 per cent of the time when they took no seconds of dessert.

Nervous Behavior at Noon Meal. During four years of the study, records were taken during the noon meal recording "nervous" or restless movements shown by the children while they were eating. Repeated five-minute observations were made such as those described by Olson (9). The types of nervous behavior most frequently exhibited were reported and the number of types shown during the five-minute observation periods.

The median number of forms per five minutes was three. In the middle fifty per cent of the meals, the children averaged from 2 to 4 forms and in the total range of meals there was no nervous behavior to 8 and more types in a five minute observation.

The types of nervous behavior which were studied have been described (6). The names refer to the part of the body most involved in the restless movements, i.e., "respiratory: hiccoughing, barking, sobbing, sighing, yawning, snuffing, blowing through nostrils, whistling inspiration, exaggerated breathing, clearing throat, making sucking or smacking or chewing sounds." The types which these children showed in the order of their frequency may be seen in Table 1 and were: bodily, pedal, manual, oral, vocal, bucco-cervical, respiratory, hirsutal, facial, vocal-repetitional, nasal, aural, ocular, kinetic-repetitional, alimentary and genital.

In from one-half to two-thirds of the meals, no part of the meal was

TABLE 1

PERCENTAGE OF TIME DIFFERENT TYPES OF NERVOUS BEHAVIOR WERE SHOWN DURING NOON MEAL AT NURSERY SCHOOL

Type of Nervous Behavior	Median	Interquartile Range	Total Range
		Per Cent of Time	
Bodily	73	54 - 86	0 - 100
Pedal	53	24 - 77	0 - 100
Manual	39	14 - 65	0 - 100
Oral	38	15 - 62	0 - 100
Vocal	19	0 - 48	0 - 100
Bucco-Cervical	10	0 - 30	0 - 100
Respiratory	4	0 - 23	0 - 100
Hirsutal	3	0 - 24	0 - 100
Facial	0	0 - 19	0 - 100
Vocal-Repetitional	0	0 - 17	0 - 100
Nasal	0	0 - 13	0 - 100
Aural	0	0 - 5	0 - 100
Ocular	0	0 - 2	0 - 100
Kinetic-Repetitional	0	0 - 0	0 - 100
Alimentary	0	0 - 0	0 - 100
Genital	0	0 - 0	0 - 75

outstandingly high or low in frequency of restless movements. When there were differences, the higher frequencies tended to occur at the middle of the meal. The lower frequencies tended to occur at the beginning or end of the meal.

These results indicate a good deal of restless movement while eating. Large body movements such as twisting and squirming were so common as to be considered characteristic of this age, as well as localized movements of the hands and feet and of hand to mouth, and meaningless vocalizing. Restlessness more evident at the middle of the meal may be associated with the effort to finish the dinner foods. The decrease in nervous behavior at the end may be associated with eating the dessert.

Sleeping Behavior

The children's sleep was reported by the teachers for nap in the nursery school and by the parents for naps at home and night sleep. Due consideration must be given to the difficulty of telling accurately whether another person is awake or asleep at any given moment. The trends obtained, however, are believed to be fairly representative.

Nap. The time each child went to bed was noted, and the time he became quiet and apparently dropped asleep. The interval between these two, called the sleep-going time, has been included for both afternoon and night sleep.

Analysis shows that the median time to bed at nap was 12:41 o'clock with the children falling asleep quickly, that is in 20 minutes or less. This may be compared favorably to the study of naps by Scott (14) where the average time taken to go to sleep for a group of nursery school children, 22 to 53 months of age, was 38 minutes. The median length of naps was 77 minutes which was close to the average length for Scott's children which was 73 3/4 minutes. The middle fifty per cent of the naps ranged from 57 to 99 minutes with a total range from no nap at all to three hours and more. Only 8 per cent of the days did the children average no naps at all.

Night Sleep. Records of the night sleep show that the children went to sleep quickly at night also, that is in 20 minutes or less and that they were asleep by 7:15 P.M. with the range for the middle fifty per cent between 6:45 and 7:45. However at times the children were asleep as early as six and as late as 9:30.

The median number of hours slept at night was 11 hours and 27 minutes, with the range for the middle fifty per cent of nights between 10 hours and 56 minutes and 12 hours. On some nights however, certain children slept 8 hours and 25 minutes or less and on other nights 13 hours and more. The length of time in bed at night reported for the median Merrill-Palmer child (16), 24 to 36 months, was 11 hours and 44 minutes. But we do not know how long he was in bed before going to sleep.

Twenty-four Hour Sleep. The median amount of sleep in 24 hours, including nap and night was 12 hours and 43 minutes with an interquartile range of 11 hours, 59 minutes to 13 hours, 21 minutes. The total range of sleep for nap and night was from less than 8 hours, 25 minutes to 15 hours, 30 minutes.

In a study of sleep by Reynolds and Mallay there were eight preschool children, two years to two years and 11 months. The mean time to go to

sleep at night was an hour, the mean night sleep was 11 hours, 1 minute and the mean total sleep was 12 hours, 30 minutes. This was a summer study. By comparison, the children in this study fell asleep more promptly and slept longer both at nap and night.

The median time of getting up in the morning was at 6:52 A.M. On the middle fifty per cent of days, the children got up from 6:22 to 7:14 A.M. At times, however, the children would get up before five or as late as 8:30.

Outdoor Play

The median amount of outdoor play time which these children had was 135 minutes a day. The middle fifty per cent of the days they had 85 minutes to three hours and more. Only two per cent of the days did the children average no playtime outside.

Elimination

Preschool children have so recently left behind infantile practices of elimination that it is of interest to know what stages they have reached toward adult standards of bladder control and defecation.

Enuresis. Records of enuresis in terms of bed-wetting at night and at naps were kept by the parents at home and by the teachers at nursery school. On the average, the children were dry 79 per cent of the days and nights. However, when the children were ranked according to the percentage of time they were dry at both night and nap during the year, it shows the median child dry 91 per cent of the time, with the middle fifty per cent of the children dry from 69 to 98 per cent. The total range was from 4 to 100 per cent. Eight of the children were dry all the time. At nap, the median child was dry 99 per cent of the days, with the middle half dry at nap from 96 to 100 per cent.

Over half of the nights, the children were taken up once for the toilet. Twenty-one per cent of the nights they were not taken up at all, and 24 per cent they were taken up twice and more.

Bowel Movements. The number of bowel movements per day and the times which they occurred were recorded for the children both on the days at home and the days at school. When the children were ranked according to the proportion of days on which there were no movements, a few tended to miss movements as often as 15 to 18 per cent of the days, while 17 of the group never missed a day. The median of the group missed one per cent of the days, with the middle half of the children not having movements from zero to three per cent. Averaging the distributions shows that 68 per cent of the days there was one movement, 25 per cent, two movements and 4 per cent, 3 movements and more. Only 3 per cent of the days did the children average no movements at all.

In spite of the usual teachings of hygiene that bowel movements should occur regularly after breakfast, the greater proportion, or an average of 42 per cent of the days, the movements were in the afternoon or evening, and 32 per cent of the time they were in the morning. On 18 per cent of the days, there were movements in both morning and afternoon.

Sickness

How much children of preschool age are sick was a question thought

worth answering for this group of 66 children. In the attendance book, the days which they were absent from school were recorded and the reasons for the absences as given by the parents. These reasons have been classified under five headings. Colds refer to respiratory infections; digestive upsets to difficulties of the alimentary tract. Diseases and infections are self-explanatory. Under "observation" are included those absences when a child was tired or thought to be coming down with a cold or other difficulty.

Compared to reports from other nursery schools, the attendance during these five years was unusually good. Conrad and Jones (4) report that the days of absence in the nursery school of the University of California were 34.5 per cent, which is similar to the report by Anderson (1) at Minneapolis and Bott (13) at Toronto.

The median per cent of school days for all causes was 16 per cent with the middle half of these children being absent from 10 to 22 per cent of the possible school days. One child was absent as little as 3 per cent of the time, while at the other extreme another lost 46 per cent. However, in order to make a comparison with the figures gained by the investigators noted above, the per cent of possible school days on which the children were absent for each of the five years was: 13, 15, 21, 16 and 20 respectively.

The median per cent of total school days absent because of sickness was 13 per cent with colds causing from 60 to 77 per cent of the sickness. Ten per cent of the total school days was lost because of colds, the middle fifty per cent of the children losing from 6 to 16 per cent. With some, however, colds caused as little as 2 per cent absence, while others lost as much as 44 per cent of the school days. Compared to the data from Merrill-Palmer (16), where the median child (24 to 41 months) was absent 23 per cent of school days and 18 per cent of the school days for colds, the children here appeared unusually healthy.

The median number of colds during the school year was 4 with the middle half of the children having from 3 to 6 and the total range was 1 to 9 colds per year.

The median of the average number of days lost from school per cold was three days. Very often the colds continued over a week end, so the actual length of a cold would be somewhat longer than this.

The median per cent of total time lost from school because of digestive upsets was one per cent, with the middle half of the children losing from no time to 2 per cent of the days. One child, however, lost as much as 8 per cent. Thirty-two of the children, almost half, had no digestive difficulties at all.

The median amount of time lost because of "observation" was but one per cent. Nineteen children were not absent for this reason, while 1 child lost as much as 10 per cent.

There were few contagious diseases among this group. The chief cause of disability was German measles. The complete list includes ten cases of German measles; one of measles; one of cystitis; one of conjunctivitis; four children had whooping cough, three of which were immediately withdrawn from the enrollment, and therefore were not counted as absences.

SUMMARY AND CONCLUSIONS

Descriptions have been presented of the health and development of 66 children, enrolled in the junior nursery school of the New York State College of Home Economics at Cornell University, during the five years, 1932-37. Average performance was represented by median scores, while the interquartile range was used to describe the variations of the middle half of the children and the total range to mark the outer boundaries of the group.

If the tendencies shown by the median scores of this group could have been incorporated into one child, this composite or "average" child would have had a mother 30 years old and a father 33 at the age of his birth. He would have weighed 7.63 pounds at birth (if a girl, 7.38 pounds). He would have been breast fed for 1 1/4 months. His first tooth would have appeared at 6 3/4 months and he would have walked at 14 months.

At beginning nursery school, this "average" child would be 2 years, 7 months old, weighing 33.19 pounds (31.38 if a girl). His height would be 37.3 inches (if a girl, 36.6). The weight-height index would be .88 and he would be six per cent over the New York state averages in weight for his height and age. He would also be five per cent over height for his age. His rate of gain in weight since birth would have been .76 pounds per month.

The physical examination would show this child to have fair muscular development and good tissue tone. In posture, his back would be straight with even shoulders and erect chest. The chances would be even for a prominent abdomen, one to three for knock-knees and pronated feet, one to four for eczema or patches of roughened skin, one to four for strabismus of one or both eyes, one to four for infected tonsils, though these may have been removed by the time of entering nursery school. He would have 19 teeth. His lungs and heart would be normal. His blood analysis would show hemoglobin at 81 per cent and a red cell count of 4,290,000. There would be about one out of five chances for a positive test for sugar at some time during the course of the year.

The Merrill-Palmer test would yield an I.Q. of 113.

Development during the year would show this "average" child gaining 1.9 ounces per week and .25 inches per month, with a mean deviation in weight per week of 2.93 ounces.

At the noon-meal in the nursery school, he would require 45 minutes to eat 25 units of food with an efficiency score of 81. Breadstuffs and protein would be eaten early in the meal, next would come potatoes or vegetables. Full servings, including both first and second helpings would include 3 1/3 tablespoons protein, 3 1/2 tablespoons vegetable, 4 tablespoons potato, 3 sandwiches (each equal to 1/4 slice of bread) and 7 1/2 tablespoons dessert. One cup of milk was included with the meal. On an average of 3 to 11 per cent of the time the child would take no second servings of the dinner foods, and 40 per cent of the time, no second dessert.

This "average" child would show three forms of nervous behavior per five minutes during the meal. The five most common forms would be bodily, pedal, manual, oral and vocal. The five types of nervous behavior shown least would be genital, alimentary, kinetic-repetitional, ocular and

aural. The nervous behavior would be most frequent at the middle of the meal and least at the beginning and the end.

As for sleep, the "average" child would go to his nap at 12:41 P.M., falling asleep in 20 minutes or less and sleeping 77 minutes. At night also he would fall asleep in 20 minutes or less, getting to sleep by 7:15 P.M. He would awaken in the morning at 6:52, having slept 11 hours and 27 minutes. His total sleep in twenty-four hours, including nap and night would be 12 hours and 43 minutes.

The amount of outdoor play of this "average" child would be 2 hours and 15 minutes daily, with only 2 per cent of the time that he would not be outside at all.

As for elimination, 91 per cent of the days and nights, he would be dry and 99 per cent of the time he would be dry at nap. Most of the time he would be taken up once for toilet at night. About 1 per cent of the days he would have no bowel movement. Most of the time he would have one bowel movement daily which would more likely be in the afternoon than in the morning.

Colds would cause the most sickness during the nursery school year. Sixteen per cent of the possible school days, he would be absent; 13 per cent of the days because of sickness of all kinds - 10 per cent because of colds, 1 per cent because of digestive upsets, 1 per cent because of "observation" for symptoms and 1 per cent because of other diseases or infections. He would have four colds during the year, which would cause him to lose about three days from school per cold.

In summary, it may be observed that for the most part these children were favored in their health and development. Their parents were older and they were not breast fed as long as children described in other studies; they were superior in weight at birth and weight and height at beginning school. They were early in teething, slow in walking. They were above average in mental development. They were good sleepers. There was less sickness among this group that has been described in other nursery schools.

While the median scores represent the health and development of the group, it is equally important to recognize the range of behavior which occurred among these apparently normal children.

TABLE 2

INFANT DEVELOPMENT

	Median	Interquartile Range	Total Range
Age parents, at birth, years			
Mother	30	25.5 - 34.0	22 - 41
Father	33	28.0 - 37.0	23 - 49
Birth weight, pounds			
Girls	7.38	6.56 - 8.38	5.69 - 10.19
Boys	7.63	6.88 - 8.50	4.88 - 10.25
Feeding and development			
Breast feeding, months	1 1/4	0 - 5	0 - 10
Age, first tooth, months	6 3/4	5 - 9	3 1/2 - 13
Age, walking, months	14	12 - 15	9 - 18

TABLE 3

STATUS AT BEGINNING NURSERY SCHOOL

	Median	Interquartile Range	Total Range
Physical development			
Age, years and months			
Group	2,7	2,4 - 2,10	1,11 - 3,3
Girls	2,7	2,4 - 2,10	1,11 - 3,3
Boys	2,7	2,4 - 2,10	2,1 - 3,2
Weight, pounds			
Group	31.95	29.56 - 34.63	26.69 - 42.0
Girls	31.38	28.88 - 34.38	26.69 - 36.81
Boys	33.19	29.69 - 35.19	27.38 - 42.0
Height, inches			
Group	37.1	36.0 - 38.0	33.3 - 41.0
Girls	36.6	35.5 - 37.9	33.3 - 39.5
Boys	37.3	36.4 - 38.2	34.3 - 41.0
Over, under weight, per cent			
Group	-6	+1 to +11	-9 to +22
Girls	+6	+2 to +14	-7 to +22
Boys	+6	0 to +10	-9 to +18
Over, under height, per cent			
Group	+5	+2 to +8	-2 to +13
Girls	+4	+2 to +7	-2 to +13
Boys	+5	+3 to +9	0 to +13
Weight-height index			
Group	.88	.82 - .93	.75 - 1.10
Girls	.87	.82 - .93	.75 - .99
Boys	.88	.82 - .93	.78 - 1.10
Gains in weight since birth, pounds per month			
Group	.78	.70 - .86	.63 - 1.05
Girls	.78	.69 - .83	.66 - 1.02
Boys	.78	.70 - .88	.63 - 1.05
Muscular development	++	++ to +++	+ to ++++
Tissue tone	+++	++ to +++	+ to ++++
Blood analysis			
Hemoglobin, per cent	81	76 - 88	70 - 92
Red cell count	4,290,000	4,100,250-4,607,500	4,000,000-5,270,000
Mental development, IQ			
Initial Merrill-Palmer test	113	106 - 125	82 - 153

TABLE 4

DEVELOPMENT DURING SCHOOL YEAR

	Median	Inter-quartile Range	Total Range
Physical growth			
Average gain weight per week, ounces			
Group	1.9	1.5 - 2.4	1.0 - 5.0
Girls	2.0	1.7 - 2.5	1.2 - 3.7
Boys	1.8	1.4 - 2.3	1.0 - 5.0
Average gain in height per month, inches			
Group	.25	.23 - .29	.03 - .40
Girls	.25	.23 - .30	.03 - .40
Boys	.25	.23 - .28	.15 - .32
Mean deviation weight per week, ounces			
Group	2.93	2.51 - 3.39	1.73 - 5.11
Eating behavior at noon meal			
Measures			
Time at meal, minutes	45	37 - 55	10 - 89
Amount eaten, units	25	21 - 30	3 - 49
Efficiency	81	71 - 90	30 - 100 and more
Selection of foods			
Order eating breadstuff	2nd	1st to 3rd	1st to 5th
Order eating protein	2nd	2nd to 3rd	1st to 5th
Order eating potato	3rd	2nd to 4th	1st to 5th
Order eating vegetables	3rd	2nd to 4th	1st to 5th
Amount breadstuff,* sandwiches	3	2 - 4	0 - 9 and more
Amount protein,* tablespoons	3 1/3	2 1/3 - 4 5/8	0 - 9 and more
Amount potatoes,* tablespoons	4	3 - 5	0 - 9 and more
Amount vegetables,* tablespoons	3 1/2	2 1/2 - 5	0 - 9 and more
Amount dessert,* tablespoons	7 1/2	0 - 12	0 - 14 and more
Nervous behavior during meal			
Number forms per five minutes	3	2 - 4	0 - 8 and more
Sleeping behavior			
Nap			
Time to bed, P.M.	12:41	12:30 - 12:57	Before 12:30 - 1:00 and later
Sleep-going, minutes	20 and less	21 - 40	0 - 41 and more
Total sleep, minutes	77	57 - 99	0 - 180 and more
Night sleep			
Sleep-going, minutes	20 and less	21 - 40	0 - 41 and more
Time asleep, P.M.	7:15	6:45 - 7:43	Before 6:00 - 9:30 and later
Time awake, A.M.	6:52	6:22 - 7:14	Before 5:00 - 8:30 and later
Total sleep, hours, minutes	11:27	10:56 - 12:00	8:25 - 13:00 and more
Twenty-four hour sleep			
Total sleep, hours, minutes	12:43	11:59 - 13:21	8:25 - 15:30
Outdoor play			
Time outside per day, minutes	135	85 - 180 and more	0 - 180 and more
Elimination			
Enuresis			
Dry day and night, per cent of time	91	69 - 98	4 - 100
Wet at nap, per cent	1	0 - 4	0 - 23
Time taken up per night	1	0 - 1	0 - 2 and more
Bowel movements			
Frequency per day	1	1 - 2	0 - 3 and more
Days with no movement, per cent	1	0 - 3	0 - 18
Sickness			
Days absent, all causes, per cent	16	10 - 22	3 - 46
Days absent, sickness, per cent	13	7 - 18	2 - 45
Days absent, colds, per cent	10	6 - 16	2 - 44
Days absent, digestive upsets, per cent	1	0 - 2	0 - 8
Days absent, "observation", per cent	1	0 - 2	0 - 10
Days absent, other diseases, per cent	0	0 - 0	0 - 21
Number colds per child	4	3 - 6	1 - 9
Average number days absent per cold	3	2 - 4	1 - 8

*Total amount for the meal. First servings of 1 tablespoon each of protein food, potato and vegetable, together with 1 sandwich, 1 cup of milk and 5 tablespoons of dessert were given by the adult. Second helpings were taken by the children themselves.

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A LONG-TERM STUDY OF CHILDREN: THE CAMBRIDGE-SOMERVILLE YOUTH STUDY

P. S. deQ. CABOT[1]

I. ORIGINS

The Cambridge-Somerville Youth Study is a private social agency sponsored by the Ella Lyman Cabot Foundation. Founded in 1935 by Dr. Richard C. Cabot, former president of the National Conference of Social Work, the agency has as its chief objective the prevention of delinquent careers in a group of boys with whom trained and experienced counsellors will work over a period of ten years. Closely related to this objective is the equally important one of measuring the degree of success or failure in preventing delinquency. Thus treatment and research objectives are closely intertwined. Many other subsidiary researches may be carried out, such as, the causes of delinquency, longitudinal studies of personality development, the interrelationship of physical, social, mental, and emotional factors and antisocial behavior, the validation of techniques of selection, of multivariate matching procedures, of predictions of delinquency, as well as an evaluation of case records.

II. PHILOSOPHY

Previous to the inception of the Cambridge-Somerville Youth Study, Dr. Richard C. Cabot had been impressed with the necessity for checking on the outcomes of social work particularly in the field of the prevention of delinquency (1). Many of the ideas expressed by him in his presidential address in 1931 at the National Conference of Social Work have been incorporated in the basic philosophy of the Study.

It is recognized that many criminal careers have their origins in early childhood, and that preventive work in this field should therefore deal with the young child who displays delinquent tendencies (2).

The work of the counsellor in the C.S.Y.S. is carried out in the belief that whatever can be done to favor the growth of character is thereby an effective prophylactic against later delinquency. From this viewpoint, the program can be justifiably described as one of character development. Help is given to a boy to develop as fully as possible his spiritual powers, his physical capacities, and mental abilities, and to achieve adequate emotional security and social development. To this end the C.S.Y.S. relies a great deal upon the services of churches, hospitals, schools, and social agencies with varying functions. Above all else the family is regarded as an essentially fundamental unit of society, and only in rare cases is a decision made to place a boy in a foster home. The efforts of counsellors working closely with boys on an intensive basis are integrated in a social casework relationship. By a friendly interest in a boy's problems, each counsellor hopes to supplement but not replace what would normally be a satisfactory parent-child relationship. Another principle observed is that all casework with the child be carried out in close cooperation with the public and parochial schools.

While the C.S.Y.S. program is one of treatment, carefully planned

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research procedures and methods have been followed from the beginning. It is extremely doubtful, however, whether the present stage in the work could have been reached if the approach had been simply investigational in nature and if research objectives were of primary importance. It has been understood from the beginning that if a family or a school is asked to cooperate in this attempt to evaluate casework in delinquency prevention, teachers and parents should feel that if they give information, they and the child should receive some service.

III. METHODOLOGICAL PLAN[2]

With no precedent to follow, it was difficult at first to envisage clearly what the sequence of methodological procedures would be. At present, there are two groups of boys, approximately 325 in each. The "Treatment" group consists of those boys who will continue to receive help from a staff of counsellors for the duration of the Study, and who were no older than twelve when treatment began. Each of these boys has been "matched" as carefully as possible with another boy belonging to the other group, known as the "Control" group. The behavior of the "C" boys will be noted during the treatment period and evaluations of the behavior of the "T" and "C" groups made throughout the duration of the program. The final evaluation will take place at the termination of the treatment period. The population of each "T" and "C" group is further subdivided into three lesser groups: 1. The "difficult" or "D" group consists of boys who at the time of selection were diagnosed as likely to be delinquent; 2. The "average" or "A" group consists of boys who were diagnosed as not likely to be delinquent; 3. A so-called "zero" or "Z" group, smaller in number than either the "D" or "A" group, includes boys about whom there was considerable diagnostic and prognostic doubt. It is possible therefore to make the following comparisons within each of the "T" and "C" groups:

TA -- CA	TD -- CA	TZ -- CA
TA -- CD	TD -- CD	TZ -- CD
TA -- CZ	TD -- CZ	TZ -- CZ

Comparisons of the behavior of the boys belonging to each of the "A", "Z", and "D" sub-groups within the larger "T" and "C" groups can also be made.

IV. EVOLUTION OF THE PROGRAM

From 1935-1939, six clearly defined stages of progress may be noted:

1. Pre-Selection

After permission was obtained from the school committees of Cambridge and Somerville (Massachusetts), much work was done in interpreting the objectives of the C.S.Y.S. to social agencies and the public schools, and every precaution taken to insure as complete an understanding of the nature of the project as was possible at that time. Especially great care was taken to prevent the use of such terms "delinquent", "behavior

[2] *A detailed report of the theory and techniques relating to these stages of the program will appear later.*

problem", "maladjustment" when referring to any boy or group of boys then or later included in the program.

Early in the 1935-1936 school year, teachers in public and parochial schools were asked to submit the names of boys who, in their opinion, needed the kind of help the agency was prepared to offer. In addition, social agencies, community and recreational centers were asked to submit names. Schools also nominated so-called "average" boys at the time when the names of "difficult" boys were submitted, so that ages and grade placement were equivalent. Altogether 1866 boys were thus referred. Teachers then filled out specially devised rating scales, at the same time supplying more complete personality data of the boys.

Simultaneously with the collection of additional information, certain refined procedures were initiated for reducing the total number of referrals from schools and agencies.

Each boy was interviewed by the physician at the time of his physical examination, and psychologists administered various achievement and intelligence tests. The latter included group and individual tests. After a boy had been examined in the school, a woman Home Visitor interviewed the parents in their homes, explaining in simple terms the nature of the program and enlisting their cooperation. Information was obtained about the boy's developmental history, his recreational interests, attitudes in the home, the family economic circumstances, the occupational history, education, health, and personality of both parents, history of the siblings, a description of the neighborhood and home conditions, and the total family pattern as it appeared to affect the boy.

The teacher of each boy was interviewed, and social agencies, hospitals, and clinics, to whom the family was known, were consulted and reports abstracted by a field worker. Each staff member who either interviewed the boy or reviewed a particular set of data relating to him recorded his or her impressions of the boy. These ratings accompanied by a personality sketch were made by staff members independently of one another.

A very important step in the diagnostic stage of the program was a series of over-night camping trips instituted in July, 1937, under the supervision of two staff members. These boys, 47 in number, were carefully selected from the oldest group in the program at that date. The trips helped to establish cordial relationships with the boys' families, indicating that the C.S.Y.S. was anxious to offer tangible services. The impressions gained from this experiment enabled the staff to revise and to reinterpret the information on these particular boys, as well as to point the way for future diagnostic developments. Careful personality descriptions on each boy were recorded, as well as observations on each group which was never greater in number than ten nor less than five.

All the information collected by psychologists, physician, home visitor, and teacher interviewer, as well as that obtained from rating scales, social agency contacts, and other sources, constituted the folder content which was submitted to a selection committee composed of a psychiatrist and two social workers.

All forms, rating scales, and procedures used in the "pre-selection" stage of the program were adopted only after they had been submitted to the closest scrutiny and after they had been used on small try-out groups of boys.

2. Selection of Boys

In addition to many preliminary conferences, twenty-five meetings of the Selection Committee were held from October, 1937, to January, 1939. Each member of the committee reviewed the folder content independently of his colleague, and when a particular set of cases was surveyed, a round table conference on each boy was held before a final decision was made. Where complete agreement on the final disposition of each boy was impossible, a particular technique was devised whereby majority and minority decisions were recorded. 782 boys were selected of whom 360 were diagnosed as "difficult", 334 as "average", and 88 as belonging to the "zero" group.

3. Matching

Despite the seemingly insuperable difficulties involved in matching or pairing boys, a matching committee of three staff members proceeded to find "diagnostic twins".

The folder content of each boy was carefully analyzed and transferred to code data sheets so arranged that the data were broken down into approximately 160 separate items grouped under such categories as general and medical information, developmental and personality data, educational and mental status, personality ratings, and final disposition.

After a searching clinical review of the code data sheets - the actual pairing process - the information on boys thus matched tentatively was transferred in numerical form to analysis sheets and grouped in accordance with a definite conceptual scheme. Examples of the variables noted on the analysis sheet are: chronological age, dominant stock, birthplace of each parent, religion, locality, school, grade placement, physical health, intelligence, attainment, and educational quotients, mental health, social adjustment, judgments of the selection committee, home ratings, standard of living, occupational status of father, neighborhood, school occupational level, etc. Descriptive reports were made together with a summary of conclusions and reasons for the match. 650 boys were finally matched, of whom 325 constituted the "Treatment" group and a similar number the "Control" group.

4. Assignment

After the population selected by the Selection Committee had been exhausted in the matching process, an arbitrary division of boys into "T" and "C" groups was made. The assignment of cases to counsellors, many of whom are trained social workers and others of whom have had considerable experience with adolescents and young boys, began November 12, 1937, and finished May 13, 1939.

When boys were assigned to counsellors, due attention was paid to many factors such as, the boy's age, school attended, personality, apparent needs, the qualifications and sex of the counsellor, the place of the boy's residence. For a full-time counsellor, the average case-load was approximately thirty-four.

5. Treatment

June 1, 1939 was arbitrarily set as the date when treatment began after the last case had been assigned. Owing to the fact that five boys have moved to places where effective treatment by the staff is impossible and that two boys have died, the present number of the total treatment case load is 318.

The following is a summary of the C.S.Y.S. treatment program during 1939:

TABLE 1

NUMBER OF INTERVIEWS MADE BY COUNSELLORS DURING 1939

Individual or Agency Interviewed	Number
Families	2353
Boys	2717
School	1119
Social Agencies	521
Settlements, etc.	236
Hospitals	485
Delinquency Squad and Police	117
Probation Officers	59
Court	23
Inter-Staff (C.S.Y.S.)	577
Miscellaneous	276
Total	8483

TABLE 2

SUMMARY OF SERVICES DURING 1939

Services	Number of Individuals	Services	Number of Individuals
Psychological		Family Problems	
		Economic	
Testings	60	Cash	14
Remedial Work	30	Clothing	21
Referred for		Advice	85
further tests	92	Employment	61
		Personal Adjustment	
		Behavior	131
Psychiatric	22	Marital	25
		Others	67
		Health	105
Educational		Foster Home Placements	7
		Miscellaneous	35
School	279	Religious	
Boy	216		
Family	183	Church Duties	33
Other	28	Priests, etc.	39
		Others	23
Recreation		Health	
Settlements, etc.	102	General Physical	80
Trips, etc.	267	Special Examinations	96
Special Training	50	Treatment Plans	119
Hobbies	45	Dental Examinations	55
Camps	109	Dental Treatment	25

Some of these specialized services that could not be provided directly by this organization have been given by 88 cooperating agencies in greater Boston, including clinics, hospitals, child welfare organizations, state departments, etc.

When a family moves to another locality, the cooperation of that particular school system is enlisted. At present, 10 school systems are cooperating with the agency. The following is a distribution of the total number of boys in the program among public and parochial schools in Cambridge and Somerville.

TABLE 3

DISTRIBUTION OF BOYS IN CAMBRIDGE AND SOMERVILLE BY SCHOOLS

Cambridge	No. of Schools	No. of Boys
Public	21	356
Parochial	10	65
Somerville		
Public	28	180
Parochial	3	7

The remaining 36 boys of the C.S.Y.S. population attending public or parochial schools are located in the 10 other school systems in Massachusetts.

Regular monthly case conferences are held between the director and each member of the counselling staff. In addition, the services of a case consultant are available. Monthly meetings are held with a casework committee consisting of three staff members of social agencies in greater Boston. In addition to regular staff and counsellors meetings, staff seminars coordinate the agency's thinking and practices.

6. "Control" Program

The determination of the program of the supervisor of the "Controls", whose responsibility is to collect, integrate, and interpret data on the "C" boys, resides in two sets of factors: 1. the general objectives of the agency; 2. the degree of difficulty encountered in attempts to obtain relevant material. A beginning has been made in paralleling the construction and development of the records on the "C" boys. The kind of information so far obtained on the "C" boys refers to school progress, actual apprehended delinquency, community relationships, personality development, agency contacts, special psychological tests, and medical examinations. This is done through interviews with teachers, probation officers, church officials, agency representatives, members of the treatment staff whose "T" boys may be friends of "C" boys, and summer camp directors.

As the possibilities for obtaining information develop, an extension of the present schedule for the supervisor of the "Controls" is possible concerning sources of information, the times and methods of collecting data, manner of recording, and office procedures affecting disposition and filing.

V. RESEARCH

Arising from the formulation of research questions, counsellors incorporate within their case records data which may be additional to that required for treatment purposes but which is necessary for the attempted solution of problems concerned with personality development, with the development of community relationships, or with topics concerning school progress, emotional maturity, medical, and orthopsychiatric problems, and periodic cross-sectional analyses of data on both "T" and "C" boys. It is probable that such analyses will be made at periods of no less than two or no more than three years within the originally planned ten-year period. By this procedure, the final labors of evaluation should be considerably reduced.

VI. ORGANIZATION

At present, the staff is composed of one director, nine counsellors, many of whom are graduates of schools of social work, one associate counsellor, one casework consultant, two psychologists, four volunteer tutors, one supervisor of "Controls", one secretary, and five members of the secretarial staff including a research assistant.

A general Advisory Committee consists of the following:

Dr. William Boyd, Lecturer in Education, University of Glasgow, and Director of the Child Guidance Clinic connected with the Department of Education, Glasgow, Scotland.

Dr. Stanley Cobb, Bullard Professor of Neuropathology, Harvard Medical School.

Dr. Donald J. MacPherson, psychoanalyst and psychiatrist, Boston; Instructor in Neuropathology, Harvard University.

Prof. H. A. Murray, Jr., Associate Professor of Psychology, Harvard Psychological Clinic, Harvard University.

M. le Prof. Jean Piaget, Institut des Sciences de L'Education, Université de Genève, Geneva, Switzerland.

Dr. E. C. Romberg, practising pediatrician, Boston; Lecturer in Pediatrics, Massachusetts General Hospital; Instructor in Pediatrics, Harvard University.

Dr. A. Warren Stearns, neurologist and psychiatrist; Dean of Tufts Medical School, Boston.

Dr. D. A. Thom, psychiatrist; Director of West End Habit Clinic, Boston.

Prof. Gordon W. Allport, Associate Professor of Psychology, Harvard University.

Mrs. Edith M. H. Baylor, Supervisor, Department of Study and Training, Children's Aid Association, Boston.

Prof. Phillip J. Rulon, Assistant Professor of Education, Harvard University.

Prof. Hadley Cantril, Associate Professor of Psychology, Princeton University.

Prof. E. A. Hooton, Professor of Physical Anthropology, Harvard University.

A treatment Advisory Committee is composed of the following:

Mrs. Edith M. H. Baylor.
Right Rev. Augustine F. Hickey, Pastor of St. Paul's Parish, Cambridge.
Dr. Augusta Bronner, Co-Director, Judge Baker Guidance Center, Boston.
Dr. William Healy, Co-Director, Judge Baker Guidance Center, Boston.
Mr. Cheney Jones, Superintendent, New England Home for Little Wanderers, Boston.
Mr. Theodore Lothrop, General Secretary, Massachusetts Society for the Prevention of Cruelty to Children, Boston.
Mr. Alfred F. Whitman, General Secretary, Children's Aid Association, Boston.

The closest possible relationship has been established with the two chief school systems, namely, Cambridge and Somerville, through two liaison officers, Miss Gertrude B. Duffy, Supervisor of Mental Tests and Measurement, Cambridge, and Mr. Everett W. Ireland, Superintendent of Schools, Somerville.

The following are some of the outstanding characteristics of this program of character development and delinquency prevention:

1. The selection of a group of "Control" boys who were initially matched or paired with boys in the "Treatment" group;
2. The inclusion of "average" boys in both "Treatment" and "Control" groups;
3. The selection of a typical cross-section of an American public and parochial school population;
4. The importance of the personal influence of well-trained and experienced counsellors upon the boy;
5. Long-time and continuous treatment of boys during the pre-adolescent, adolescent, and early adult years;
6. As much as possible, prevention of the development of problems of delinquent behavior rather than the treatment of symptoms of delinquency;
7. The inclusion of parochial schools;
8. The demonstration of a continuous plan of coordination of social agencies, summer camps, the school, and the home, in the interests of the individual boy;
9. The value of parental education with an attempt to maintain, wherever possible, the integrity of family relationships;
10. The importance of integrating a tutoring and a remedial reading program with casework procedures;
11. The combination of research and casework;
12. Careful planning for purposes of evaluation;
13. The basic philosophy of the program.

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FELS MENTAL AGE VALUES FOR GESELL SCHEDULES

VIRGINIA NELSON AND T. W. RICHARDS[1]

One of the tests most widely used at the infant level is the Gesell Schedules (3). Gesell presents no device for standardization of total score, much less mental age. In our work here at Fels we have found it useful in graphing progress of the individual child to use mental age where possible, and the standard score method for other variables. Since the Gesell Schedules are not standardized in terms of mental age, it was impossible to plot the child's score in these terms without developing norms of such type. The present report presents the tentative mental age norms we developed for our own use, on the supposition that such norms for the Gesell Schedules might be useful elsewhere.

Children were tested[2] at half-yearly intervals by means of the Gesell Schedules at 6, 12, 18, and 24 months, the Merrill-Palmer Scale at 24, 30, 36, 42, 48, and 54 months, and the Stanford-Binet at 36, 48, and 60 months. Since the Fels study is a longitudinal one, the group studied is, or will be, composed of the same children at each age level. Obviously the group becomes smaller with the increase in age, since the total group of children is spread over a period of from the fetal stage to ten years. Test results used for obtaining distributions of mental age were used only when the child was tested within a restricted period about his birthday; this period was arbitrarily set at one per cent of the total age of the child (including 280 prenatal days).

In Table 1 are presented for each age level the mean score and the standard deviation for the Merrill-Palmer and Stanford-Binet Scales, mental age values at the mean, at the mean plus one sigma and the mean minus one sigma of raw score, together with the IQ's which would result from such MA values. It is seen that the mean IQ is about 115, and there is a deviation of about 15 points in IQ to account for the sigma of mental age. If we assume that though individuals may vary longitudinally the characteristics of the group distribution as measured by the Gesell Schedules are similar to those of the distributions as measured by the M-P and S-B scales later on, that is, and that the mean variability and nature of the curve are constant, it seems legitimate to calculate mental age equivalents for the raw score Gesell values (total number of items passed) in the following way:

Let the mean Gesell score represent that mental age which provides an IQ of 115, and let the sigma in mental age for the Gesell Schedules be represented by that difference from the mean in mental age which would provide an IQ of 100 for the score at -1 sigma and 130 for the score at +1 sigma.

When these values were calculated for each of the Gesell Schedules at the age points at which we have used them, the following results were obtained:

[1]From the Samuel S. Fels Research Institute, Yellow Springs, Ohio.

[2]All tests were administered by the senior author.

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Age Levels	Mean MA	Sigma MA
6 months	6.90	.9
12 months	13.80	1.8
18 months	20.70	2.7
24 months	27.60	3.6

Mental age values for the raw score of the scales at each level may now be calculated according to the following equations:

For six months, 3.9196 + .1076555 x
For twelve months, 4.1662 + .302 x
For eighteen months, 9.492 + .389 x
For twenty-four months, 17.048 + .443 x

These equations are regression equations with an assumed correlation of 1 between age levels.

TABLE 1

AGE GROUPS, MEAN AND DISTRIBUTION SIGMAS OF MENTAL TEST SCORES, WITH MENTAL AGE AND IQ EQUIVALENTS

Scale	Age in Months	Number Cases	Score		M. A. Equivalents			I. Q. Equivalents		
			Mean Score	Sigma	Mean	Mean - 1σ	Mean + 1σ	Mean	Mean - 1σ	Mean + 1σ
Gesell	6	74	27.68	8.36						
Gesell	12	77	31.90	5.96						
Gesell	18	68	28.80	6.94						
Gesell	24	67	23.81	8.12						
Merrill Palmer		71	19.39	5.07	27	25	30	112.5	104.2	125.0
"	30	64	32.62	8.34	33	30	37	110.0	100.0	123.3
"	36	62	49.55	10.32	40	36	47	111.1	100.0	129.2
Stanford Binet		66	42.36	6.08	42	36	49	116.7	100.0	135.0
Merrill Palmer	42	64	61.81	10.29	48	42	55	114.3	98.8	131.0
"	48	56	74.41	7.94	57	51	70	118.8	105.2	144.8
Stanford Binet		58	55.03	7.66	55	47	63	114.6	97.9	131.3
Merrill Palmer	54	35	80.47	7.04	65	57	76	119.4	104.6	139.8
Stanford Binet	60	56	67.61	8.33	68	59	76	112.7	98.3	126.7
Mean								114.5	101.0	131.2

Mental age values for the Schedules at each level are presented in Table 2.

TABLE 2

MENTAL AGE VALUES FOR NUMBER OF GESELL ITEMS PASSED AT FOUR AGE LEVELS

No. Items Passed	Months 6	12	18	24	No. Items Passed	Months 6	12	18	24
1	3.8	4.5	9.9	17.5	26	6.5	12.0	19.6	28.6
2	3.9	4.8	10.3	17.9	27	6.5	12.3	20.0	29.0
3	4.0	5.1	10.7	18.4	28	6.7	12.6	20.4	29.5
4	4.1	5.4	11.1	18.8	29	6.8	12.9	20.8	29.9
5	4.2	5.7	11.4	19.3	30	6.9	13.2	21.2	30.3
6	4.4	6.0	11.8	19.7	31	7.0	13.5	21.6	30.8
7	4.5	6.3	12.2	20.1	32	7.1	13.8	21.9	31.2
8	4.6	6.6	12.6	20.6	33	7.3	14.1	22.3	31.7
9	4.7	6.9	13.0	21.0	34	7.4	14.4	22.7	32.1
10	4.8	7.2	13.4	21.5	35	7.5	14.7	23.1	32.6
11	4.9	7.5	13.8	21.9	36	7.6	15.0	23.5	33.0
12	5.0	7.8	14.2	22.4	37	7.7	15.3	23.9	33.4
13	5.1	8.1	14.6	22.8	38	7.8	15.6	24.3	33.9
14	5.2	8.4	14.9	23.3	39	7.9	15.9	24.7	34.3
15	5.3	8.7	15.3	23.7	40	8.0	16.2	25.1	34.8
16	5.4	9.0	15.7	24.1	41	8.1	16.5	25.4	35.2
17	5.5	9.3	16.1	24.6	42	8.2	16.9	25.8	35.7
18	5.6	9.6	16.5	25.0	43	8.3	17.2	26.2	36.1
19	5.7	9.9	16.9	25.5	44	8.4	17.5	26.6	36.5
20	5.9	10.2	17.3	25.9	45	8.5	17.8	27.0	
21	6.0	10.5	17.7	26.4	46	8.7	18.1	27.4	
22	6.1	10.8	18.1	26.8	47	8.8	18.4	27.8	
23	6.2	11.1	18.4	27.2	48	8.9	18.7	28.2	
24	6.3	11.4	18.8	27.7	49		19.0	28.6	
25	6.4	11.7	19.2	28.1	50			28.9	

DISCUSSION

The foregoing method of calculating mental age values makes certain assumptions which may be controversial. It assumes 1) that the function "mental ability" is similar at various points during the first five years and 2) that variability in this function is constant over this period.

Opposing the validity of the first assumption is a considerable body of evidence to show that mental tests at various ages during infancy are not highly correlated, and that they predict poorly for later mental status. This evidence merits consideration, for the lack of correlation might suggest lack of "identical elements" between tests at two age levels. From the longitudinal viewpoint, however, it is possible that correlation between two age levels, involving varied environmental forces, may be an expression not so much of "identical elements" as identical imperviousness of the elements forming the test ability to influences in the environment. Length of the body at one point is logically similar to length at a later point, as heart rate may be similar to later heart rate. But a probable higher longitudinal intercorrelation for height than for heart rate would be an expression of the fact that height is less affected by the environment than is heart rate; the degree of

identity of the phenomena is beyond question. Low intercorrelations between mental tests at early age levels may be due in part to the fact that dissimilar functions are measured; it is more likely, however, that the functions measured are similar but that children are more susceptible to deviation in these functions than they are later in life, when such intercorrelations between mental ability at various age levels are higher.

Regarding the second point in question - that is, the assumption of constant group variation in mental ability, contrary evidence of Thurstone (4) is pertinent. Thurstone is convinced that "absolute variability" in mental ability increases with age. It is not clear that this increase in "absolute variability" is an increase over and above what we would expect with a constant coefficient of variability for an increasing chronological age. Since Thurstone's method of calculating absolute variability is considerably unlike the method of calculating variability for the distributions used here, it is difficult to apply his rationale to our own situation. We have been able to check our assumption of constant variability by scoring the Gesell performances at six and at twelve months by means of the age values Bayley (1,2) obtained for certain of the items used by us. Bayley's age placement values for 24 items yielded at six months an age score which for 52 cases, correlated .893 with our raw score, and for 63 cases at twelve months (on twenty items), .735. A comparison of the mean and standard deviations of these age values with these measures for the age values obtained by our inference method follows:

		6 mos	12 mos.
Mean	Bayley	7.04	14.06
	Fels	6.90	13.80
S. D.	Bayley	0.96	1.49
	Fels	0.90	1.80

This evidence would indicate that the values obtained on the basis of what Bayley found were actual age values were not significantly less variable at six months than those obtained when it was assumed that variability was constant over this early period. The difference between the standard deviations divided by the sigma difference was .5. At twelve months the variability obtained by using Bayley's values was less (the difference divided by the sigma of the difference being 1.3).

SUMMARY

The construction of these tables of mental age values for the Gesell Schedules assumes similarity of function measured by the schedules and by repeated Merrill-Palmer and Stanford-Binet tests later than two years. It also assumes that the coefficient of variability is constant, - that variability increases with increase in mean score.

On the basis of these assumptions, mental age values for Gesell Schedules are presented in Table 2.

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A STUDY ON THE TREND OF WEIGHT IN WHITE SCHOOL CHILDREN FROM 1933 TO 1936

MATERIAL BASED ON THE EXAMINATIONS OF PUPILS OF THE ELEMENTARY SCHOOLS IN HAGERSTOWN, MARYLAND

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INTRODUCTION

In several papers Palmer (1,2,3,4) reported the results of investigations on the growth of the white elementary school children of Hagerstown, Maryland, dealing especially with the variations in the weight of the children aged 6 to 11 years during the period 1921-1927 and during some of the years (1933-1934) of the economic depression. Annual observations on the growth, particularly in weight, of the Hagerstown children have been continued by the U. S. Public Health Service so that it is possible to report on the weight of children for the years following 1933 and thus to extend the findings of Palmer. At the same time, in this and in the following series of reports it is hoped that by the comparisons of the results obtained on children of the same ages in different calendar years and on children of different age groups in the same calendar year to arrive at a better understanding of the pattern of growth characteristics of white school children.

The study of growth may be approached in three different ways. First, the results of the measurements may be given for children of the same age at different calendar years. By this method striking environmental influences upon growth may be discovered as, for instance, those that affected children of Central Europe after a short period of especially deficient nutrition during and immediately subsequent to the last World War (5). In addition, the existence of a tendency to increase in size, as has been demonstrated in many parts of the world, can also be described by such comparative measurements when they cover a long succession of years.

Second, the results may be obtained for children of the same generation at successive years of age. This would be the case if we were able to pursue a school generation, let us say, from 6 years of age in 1930 throughout the whole school life until the age of 16 years in 1940. The characteristics of the pattern of growth of the same generations could thus be described when it is assumed that the hereditary and environmental factors for the group as a whole have been almost constant and provided that the number of children does not greatly diminish or change throughout the years of observation (6,7). We could call the resulting pattern the average "individual" or "longitudinal" growth curve for the specified generation (e.g., school generation - 1930, 6 years of age or, correspondingly, birth generation 1923-24) and compare it from many points of view with other generations, former or later ones of the same

[1]*From the Division of Public Health Methods, National Institute of Health, U. S. Public Health Service and the Milbank Memorial Fund.*
The author is deeply indebted to Doctor Antonio Ciocco for specific suggestions to improve the text and for invaluable criticism during the preparation of the paper.

CHILD DEVELOPMENT, Vol. 11, No. 3 (September, 1940)

place, or with the corresponding generations in other cities, states, nations, races, etc.

This second method of study is usually not applied for want of sufficient consecutive data on a large number of children of the same generation over a relatively long period of time. Therefore, the data are mostly combined from different generations or, in practice, from all the different age classes present in the same calendar year. This is the third method or the most common way of constructing a growth curve for practical purposes. By doing so we assume that the observed differences from age group to age group represent the pattern of growth in the successive ages of the same generation, or the growth curve of the average individual from a given time on. In other words, we do about the same in this case as when constructing a life table.

However, it must not be forgotten that when the life table technique is used the observations dealt with always concern a series of simultaneously living generations. An unforeseen bio-sociological event may change greatly the variables involved as, for instance, in the case of mortality, a sudden pandemic may occur or some deteriorating factor may diminish the general resistance of the population. It will be recalled that in Europe in the first World War in addition to the battle losses, influenza epidemics, tuberculosis and starvation increased enormously the general mortality of the populations involved. The experiences in Europe during and after the war of 1914-1918 similarly indicate that such phenomena can also affect the rhythm of growth of certain generations of children. In Germany and Austria it was shown that those generations of children whose infancy and early childhood coincided with the starvation period of the war and of the immediate post-war period suffered a distinct retardation of growth, in weight as well as in height (Martin (8), Peller (9), Schlesinger (10), Wolff (11)), as compared with former and particularly later generations.

In the investigation of Berlin school children (Wolff) it was especially striking that the children born in the period of serious food shortage in Germany, 1917-1919, still showed six years later - when they entered school and were first systematically measured - a distinct growth deficit in comparison with earlier and, still more, with later generations of school entrants of the same ages. For example, the children who first entered school in 1932 were on the average 6.0 to 6.5 cm. taller and 1.0 to 1.6 kg. heavier than the new admissions of 1924. It will be recalled also that in an investigation on the Viennese population, Peller noted that the births of the late war years 1917-1919 and still in 1920-1922 had significantly inferior body-weight than the births of previous years. These war-time observations which in effect constitute the results of an involuntary mass experiment on under-nutrition of mother and child point to the importance of the environmental influences, probably pre- and post-natal, upon the growth of children. Such results are in good agreement with the experimental findings in mice reported by Agnes Bluhm (12) who could demonstrate the retardation of growth in young mice with low birth weights. From the above observations and animal experiments the same conclusions for man are reached as for other animals, namely; that the intra-uterine growth rate while mainly determined by heredity, nevertheless is also influenced by the environmental factor of maternal

nutrition. Moreover, this factor is apparently also responsible for a further post-foetal retardation still distinct at the end of early childhood. This phenomenon may explain the different "growing" years which, for instance, Palmer (2) found in elementary school children in Hagerstown, or the frequently observed retardation in the growth of school children from economically unfavorable social strata as compared with children from wealthier families. Such a socio-economic growth differential was particularly well shown for the growth of German children in elementary and secondary schools in the careful investigation by Oettinger (13). It seems safe, therefore, to regard such differences as due to environmental rather than to genotypic variations.

In this respect it is well to call attention to still another point about the German post-war experience. The question is often asked: Did the retardations demonstrated in the growth of the school entrants persist, or were the deficits made up in the course of the following eight years of school life which were for the most part of normal nutritional condition? An exact answer could only be given when the entrants of the years 1924-1926 left school eight years later. They are not exactly the same children because of some internal school migration, but they are of the same birth generations. The anthropometric data on school graduates in 1931, 1932 and 1933 - the measurements and computations could not be continued in the subsequent years - showed indeed no retardation in the bodily development. On the contrary these children also exhibited, in comparison with earlier generations of graduates, a general improvement. For instance, in boys 13½ - 14 years old, the increase in height of the graduates of 1933 over those of 1925 amounted to 7.2 $\pm$ 0.889 cm., in weight to 4.7 $\pm$ 0.862 kg. In girls of the same age the corresponding increases were 5.8 $\pm$ 0.870 cm. in height and 3.7 $\pm$ 0.875 kg. in weight. The added standard errors of the differences make it plain that the increases both in stature and weight lie beyond the ordinary limits of chance, being in all instances more than three times the standard errors. Therefore, there can be little doubt that the older children, born in the hunger years of the war, compensated for the growth deficit that was still manifest at the age when they entered school in 1924 to 1926. Thus a permanent injury does not seem to have resulted. These observations make it plain that even the marked growth retardations of the war-born generations were only of a transitory character, probably caused by the environmental influences of undernutrition rather than by any genotypic variation.

With these observations in mind the results obtained by the application of the three methods of study described above will be discussed in this and the following papers in which consideration will also be given to the effects of other variables of growth. In this paper, the changes in weight observed from 1933 to 1936 in the white elementary school population will be examined.

MATERIAL AND METHODS

The methods of measurement are the same as described by Palmer in the above cited papers. The weight has been recorded in pounds while height which has been measured since 1935 was in that year recorded in

inches, and in later years in centimeters. At the weighing the children discarded shoes, vests, sweaters, or coats, but retained the regular indoor clothing. The measurements have been taken each year within the first half of the month of May, the actual day of measuring varying slightly in the successive calendar years.

In the tabulation of the original data five-pound class intervals have been used. Sheppard's corrections for the effect of grouping are not applied. In this material it has been found several times by experimental computations that there is no essential difference in the final results whether the children of the same sample are grouped in five, three, or two-pound classes. Thus, to abbreviate the work of calculation, five-pound intervals have been adopted for the reduction of the actual distributions of weight.

The observational data for the four year period 1933 to 1936 covered in this study concern a total of 14,401 weights taken in successive years: 7,134 on boys and 7,267 on girls. The distribution of the number of children weighed each year may be seen from Table 1 which also gives the age range of the children.

TABLE 1

NUMBER OF BOYS AND GIRLS WEIGHED IN HAGERSTOWN, MD., 1933 TO 1936

Year	Boys	Girls	Total	Age Range
1933	1,499	1,493	2,992	6 - 13 years
1934	1,387	1,385	2,772	6 - 14 years
1935	2,026	2,023	4,049	6 - 15 years
1936	2,222	2,366	4,588	6 - 16 years
All years	7,134	7,267	14,401	-

In each calendar year a new generation, the children aged 6-7 years, enters the observation and each generation advances to a higher age class. Since the investigation started in 1933 with children 6 to 13 years of age, in 1934 the ages including the new school admissions range from 6 to 14, in 1935 from 6 to 15, and in 1936 from 6 to 16 years. However, it must be noted that the children who enter the successive age classes are not always identically the same children although a fairly large proportion of the children first observed at 6, 7, 8 - years have been individually followed through the later school years. Thus, although there is more or less a change in the actual constituents of the different age groups from year to year, nevertheless all individuals included in a specified age group during a certain calendar year represent the same generation regarding birth year.

In any anthropometric study of school children the definition and delimitation of the age of the child at examination must be considered. It often happens that confusion arises with regard to the exact limits of the age group. The children of this investigation are grouped into age classes by single years, the age being taken as of the last birthday before the date of examination assumed to be May 1st. Therefore, the age designation 6, 7, 8 - years has the meaning of completed year of age. For example, the term 6-7 years of age covers the range from exactly 6

years to 6 years and 364 days, the mid-point for the age group thus being 6½ years. This may be illustrated by the following tabulation which regards the 8-year-old girls examined in the spring of 1933 and who were born, of course, in two successive calendar years (238 in 1924 and 96 in 1925, totaling 334). The distribution of the months of birth for this eample is shown in Table 2.

In the above quoted papers on the growth of school children in Hagerstown the age was determined from the birthday nearest January 1 of the school year in which the measurements were taken (1). Since the examination took place four monthe later (in May), the children were on the average 6, 7, 8 - years + 4 months of age. In the present investigation the children measured in May were actually 6-7, 7-8, 8-9 - or 6½, 7½, 8½ years of age (in the anthropological midpoint term) as shown in the above example. Therefore, for an exact comparison of the former resulte of Palmer'e investigations with the present ones in Hagerstown, it is necessary to add the average increment of two more months in order to adjust the obtained mean weights to each other. The adjustment can be easily done since in Palmer's papers the average yearly increments as well as the average monthly increments for the eame ages are given. The somewhat different delimitation of the age classes is also the reason why the numbers of children by age claeses in the present paper, for inetance for 1933, do not agree perfectly with the former observation.

TABLE 2

MONTH AND YEAR OF BIRTH OF 334 GIRLS, CONSIDERED 8 YEARS OF AGE AT THE TIME OF EXAMINATION ON MAY 1, 1933

1924		1925	
Month	Number of girls	Month	Number of girls
May	36	January	18
June	23	February	25
July	28	March	31
August	29	April	22
September	34		
October	22		
November	35		
December	31		
Totals	238		96

THE WEIGHT OF THE WHITE HAGERSTOWN SCHOOL CHILDREN 1933 - 1936

The present analysis of the records on the weight of the Hagerstown school children from 1933 to 1936 makes it possible to extend the growth studies begun in the same community during the seven years period, 1921 - 1927. By the comparison covering almost two decades we are further enabled to deal with the question of the general and much discussed tendency of the increase in physical size observed almost all over the civilized world for some fifty years or more (cf. Bowles 16), especially from recruiting statistics and other data on adults.

The cause of this general increase of physical size is supposedly

due to the general improvement of social and economic conditions, sport, physical and hygienic education, and especially better national nutrition. Whatever the causative factors may be, the average increase is considered an established fact. For these reasons it is of public health interest to watch the height and weight constants from year to year for the same population because these may be regarded to some degree as an index of current public health conditions. In addition, it will have also importance as a contribution to the physiology of growth if we are able to follow up the same generation until the end of its growing period.

Having both features in mind, the data on the white Hagerstown school population, boys and girls of the same ages, are presented in the following tabulations. These contain for each age class the number of children examined in each calendar year - of course, not the total of the Hagerstown school population - the range of the weight distribution, the mean weight in pounds and its standard error, the standard deviation and the coefficient of variation.

BOYS AND GIRLS 6-7 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS

Starting now with the discussion of the single age groups at successive calendar years, and considering first the mean weights of the boys and girls 6-7 years of age (cf. Table 3), it is observed that for both sexes there was a slight decrease in average weight from 1933 through 1936; the lowest weight was found for both sexes in 1935: 46.34 $\pm$ 0.474 pounds for boys and 44.64 $\pm$ 0.470 pounds for girls. Although the differences from year to year lie within the limits of chance fluctuations, as can be seen when the standard errors are added to or subtracted from the respective means, the consistent tendency observed in boys and girls might have some meaning. The largest difference between the mean weights is found between that of 1933 and that of 1935 and it amounts to 1.03 $\pm$ 0.709 pounds for boys and 1.37 $\pm$ 0.748 pounds for girls. This means that for each sex the difference is not quite twice its standard error. Therefore, so long as there is no more significant proof of a real loss of weight in 1935, or of a general decline in growth (as could be demonstrated by observations on stature), it is sufficient to mention that the phenomenon is observed in both sexes.

The tendency to some decrease in the weight for this age group from 1933 to 1936 is still more emphasized when the results for these years are compared with the corresponding mean weight for the combined years 1921 to 1927 as calculated from Palmer's investigations in Hagerstown. After the age class limit has been adjusted as described above by taking into account an increment of two more months, the mean weight for the boys 6-7 years of age in 1921-1927 equals 47.62 $\pm$ 0.345 pounds while for the girls it is 46.56 $\pm$ 0.347 pounds. Therefore, if the corrections applied are acceptable, in recent years there has been a decrease of weight in both boys and girls.

The variability of weight as measured by the standard deviation and the coefficient of variation, respectively, does not vary markedly from year to year. But there is one point worth mentioning, namely; that in most of the years the girls exhibit a somewhat higher variability than

TABLE 3

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 6-7 YEARS OF AGE.

Year	Boys					Girls				
	Number	Weight				Number	Weight			
		Range	Mean ± standard error	Standard deviation	Coefficient of variation		Range	Mean ± standard error	Standard deviation	Coefficient of variation
1933	150	35-89	47.37 ± .527	6.45	13.62	148	30-84	46.01 ± .582	7.08	15.39
1934	75	35-59	47.23 ± .617	5.35	11.32	81	30-74	45.65 ± .763	6.87	15.05
1935	147	30-64	46.34 ± .474	5.75	12.40	161	30-69	44.64 ± .470	5.97	13.37
1936	129	30-64	46.84 ± .578	6.57	14.03	139	30-69	44.95 ± .515	6.07	13.50
1921-27*	238		47.62 ± .357	5.51	11.57	237		46.57 ± .357	5.49	11.79

*Mean weight and standard deviation for the combined years 1921-27 are taken from Palmer's former investigations (1-4) and adjusted to the age of the present investigation by arithmetic interpolation of the annual increments for two more months. For example, the calculated mean weight of boys, 6 years of age, was given as 46.83 pounds, the mean annual gain of those boys from 6 to 7 years of age as 4.75 pounds. Thus, for two more months of growth, the weight was increased by two-twelfths of 4.75 pounds or 0.79 pounds, which gives a total of 47.62 pounds. A fairly good estimation of the standard deviation can be obtained by interpolation of the given values at 6 and 7 years of age 5.32 and 6.44 pounds. Two-twelfths of this difference of 1.12 plus 5.32 pounds equals 5.51 pounds as the adjusted standard deviation due to the dispersing effect of growth.

TABLE 4

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 7-8 YEARS OF AGE.

Year	Boys					Girls				
	Number	Weight				Number	Weight			
		Range	Mean ± standard error	Standard deviation	Coefficient of variation		Range	Mean ± standard error	Standard deviation	Coefficient of variation
1933	202	35-84	50.89 ± .443	6.29	12.37	211	30-84	49.89 ± .531	7.72	15.47
1934	176	35-74	50.60 ± .449	5.95	11.77	176	35-99	49.80 ± .634	8.41	16.88
1935	216	35-74	51.39 ± .435	6.39	12.44	209	35-84	49.29 ± .497	7.19	14.58
1936	234	35-74	50.64 ± .440	6.74	13.30	246	30-84	48.82 ± .441	6.91	14.15
1921-27*	596		51.56 ± .270	6.60	12.80	573		49.96 ± .270	6.46	12.93

*Compare footnote to Table 3.

the boys as is demonstrated by the relative measure of variability. It may be further worth noticing that the variability conetants in both sexes were somewhat larger in the years from 1933 on than in the former period 1921-1927. This result is in agreement with Palmer's findinge for the year 1933 alone and would suggest that in the years following 1933, the years associated with the economic depression in the United Statee, there was some tendency to an increase in the variability of body weight for boys and girls.

BOYS AND GIRLS 7-8 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 4)

For this age group the average weight of boys and girle during the period of the present observation does not ehow much change nor ie there any distinct tendency to decrease. There is perhaps a small decline for girls in 1936, but the fluctuations from year to year lie within the limits of chance as the simple etandard errors of the means plainly show. The same is true if we compare the results of the present observation with the adjusted average weights of boys and girle for 1921-1927. Therefore, it seems to be reaeonably clear that the average weight of the children 7-8 years of age in Hageretown has remained fairly constant during the last two decades, taking into account the normal fluctuatione of random sampling. It may be mentioned again that in every year of observation the boys exceed in weight the girls by 1 to 2 pounde. This, of course, is beyond the limite of chance and corresponds to the biological pattern of growth with regard to sex differences in childhood.

The variability presents the same feature as for the previous age group; it is at each year distinctly larger in girls than in boys as the values of the standard deviation and coefficient of variation demonstrate. Only in the period 1921-1927 the adjusted standard deviation is somewhat smaller for girls but this is not true for the coefficient of variation. Aside from this there is nothing striking in the variability constants for each year. When compared to the preceding age (6-7 years), the etandard deviations of the 7-8 year class rise a little indicating the steadily dispersing effect of growth, again more distinct for girle. In addition, it might be worth mentioning that for girls both measures of variability tend to be greater in all the years since 1933 than in the period 1921-1927 when the standard deviation of 6.46 pounds and the coefficient of variation of 12.93 per cent exhibited the lowest level (see Table 4).

BOYS AND GIRLS 8-9 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 5)

In the four yeare under obeervation, from 1933 to 1936, there is no eignificant change in the mean weight of this age group. Even the greateet differences between 1933 and 1934 for boye, and for girls between 1935 to 1936, are reaeonably explained by the lawe of chance fluctuation ae the values of the standard errors of the reepective means indicate. Considering again the adjusted values of the period 1921-1927 there is no doubt that the average weight of the children of thie age hae been fairly conetant within the last two decadee. The boye ehow in each year

of observation a higher body weight than the girls although not as distinct as in the younger age groups. Only in the year 1936 when the weight of the boys increased whereas that of the girls decreased, as compared with the preceding calendar year, the sex difference in weight is significant in the statistical sense and amounts to almost exactly 2 pounds.

The variability of weight, as measured by the standard deviation and the relative parameter of variation, demonstrates again the existence of a wider range of weight fluctuations for girls than boys. But the most striking point in this respect is that the years under observation, in particular 1933, 1934, and 1935, when compared to the period 1921-1927, tend to be associated with a distinctly larger variation in the body weight of the girls. This finding for the years of economic crisis confirms again the former results of Palmer's investigations.

BOYS AND GIRLS 9-10 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 6)

In this age group the changes in the mean weights from year to year are obviously statistically insignificant. Even when we take the largest difference found in either sex, that for the girls who average in 1933 60.07 $\pm$ 0.694 pounds and 61.78 $\pm$ 0.909 pounds in 1936, the difference amounts to 1.71 $\pm$ 1.144 pounds and is only 1.5 times its standard error. Since all the means and their standard errors are given in the tables, the statistical meaning of the differences can be easily verified. It will be noted that from 1933 to 1936 the trend of the weights in the boys is the reverse of that for the girls: The mean body weight for the boys went down, that of the girls went up. It is impossible at this stage of the investigation to give an explanation for this finding. It could be explained by chance alone or it might be caused by some substantial factors that we do not know as yet. This inverse trend of the boys and girls, 9-10 years of age, is also the reason that only in 1933 and 1934 the mean weights of the boys are distinctly higher than those of the girls. There is almost no more difference in 1935, and in 1936 the girls are even somewhat heavier than the boys of the same age. This greater weight of the girls is not statistically significant yet it is mentioned because it is unique for this age group.

The variability of the distributions exhibits the same trend as demonstrated before. The standard deviations and coefficients of variation are remarkably larger for girls than for boys. And again in comparison with the adjusted data of the former period 1921-1927, the figures clearly indicate that no significant change has occurred for boys, whereas the variability for girls has increased in the period under observation. This finding indicates that weight is more stable for the male school child, and that the recent years of the economic depression were apparently associated with a distinct upward trend in the group variability of body weight in the female sex.

BOYS AND GIRLS 10-11 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 7)

In this age group, it may be noted that the mean weights of boys

TABLE 5

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 8-9 YEARS OF AGE.

Year	Boys					Girls				
	Number	Weight				Number	Weight			
		Range	Mean ± standard error	Standard deviation	Coefficient of variation		Range	Mean ± standard error	Standard deviation	Coefficient of variation
1933	250	35-89	56.72 ± .500	7.91	13.94	243	35-134	55.69 ± .678	10.57	18.98
1934	202	35-99	55.37 ± .481	6.83	12.34	208	35-109	55.02 ± .669	9.65	17.53
1935	212	40-94	55.85 ± .479	6.98	12.49	206	35-114	55.66 ± .708	10.17	18.27
1936	230	40-94	56.39 ± .489	7.41	13.15	234	35-89	54.40 ± .506	7.74	14.23
1921-27*	839		56.94 ± .262	7.60	13.35	811		55.14 ± .274	7.80	14.15

*Adjusted values, compare footnote to Table 3.

TABLE 6

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 9-10 YEARS OF AGE.

Year	Boys					Girls				
	Number	Weight				Number	Weight			
		Range	Mean ± standard error	Standard deviation	Coefficient of variation		Range	Mean ± standard error	Standard deviation	Coefficient of variation
1933	220	35-119	62.34 ± .626	9.29	14.90	228	40-119	60.07 ± .694	10.48	17.44
1934	233	40-99	61.92 ± .603	9.21	14.87	245	40-134	60.46 ± .774	12.12	20.04
1935	215	40-119	61.04 ± .594	8.71	14.27	222	40-124	60.90 ± .783	11.67	19.17
1936	266	40-99	61.32 ± .501	8.17	13.32	243	35-144	61.78 ± .909	14.17	22.94
1921-27*	978		62.59 ± .288	9.01	14.40	921		60.63 ± .317	9.63	15.88

*Adjusted values, compare footnote to Table 3.

and girls follow the same inverse trend as observed for the younger group. The average weight for boys, in the present period of observation, diminished from 68.50 ± 0.682 pounds in 1933 to 66.81 ± 0.606 in 1936 with a maximum in 1934, while the average weight for girls increased within the same period from 66.64 ± 0.780 pounds to 68.45 ± 0.924, respectively, with a corresponding minimum in 1934. The differences are considerable. By taking the highest and lowest values for each sex (1934 and 1936) the decrease in boys amounts to 1.84 ± 0.994 pounds, the increase in girls to 2.08 ± 1.327 pounds. Both differences, although amounting to around 2 pounds, are statistically not significant in the strict sense of the probability theory because of the high mean errors. This is especially true in the case of the girls although the difference in their weight exceeds that of the boys. However, the girls have a distinctly higher variability as demonstrated by the standard deviation and the variation coefficient and consequently the standard error is also higher. Keeping this in mind we have to state that also for this age group the difference between the average weights are statistically not significant, probably due to the dispersing effect of growth, especially for girls. On the other hand, we must not overlook the peculiar feature of an inverse trend of average weight for boys and girls in the period of economic depression.

There is not much to be added about the variability of weight in this age group. In girls as has been mentioned above, the tabulated values are greater than those of boys for every calendar year. It is further obvious that as compared with the adjusted values of the former period 1921-1927, only the girls develop, except for the year 1933, distinctly higher values of the variation parameters. Thus it suggests itself that the past years of the economic depression have increased, indeed, the variability of body weight of girls in contrast to the greater stability of weight of boys.

BOYS AND GIRLS 11-12 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 8)

It is to be seen from the tabulated mean weights and their errors that in this age group there is no consistent difference in the single calendar years from 1933 to 1936. This is especially true for the boys whose average weights are fairly constant; the fluctuations lie within the limits of a single standard error even when compared with the adjusted average of the former period 1921-1927. For girls it is a little different. Excepting the year 1933, there is again a clear tendency to an increase in body weight, from 74.71 ± 1.013 pounds in 1934 to 77.15 ± 1.123 pounds in 1936. It is the same tendency as demonstrated in the preceding age groups, 9-10 and 10-11 years. However, even the difference of 2.44 pounds, considering the high errors of the mean weights, falls within the limits of chance fluctuations. The mean error of the difference equals ± 1.512. So, the observed difference of 2.44 pounds is only 1.61 times its standard error. A ratio of this size would mean that such a deviation could occur by chance alone eleven times out of one hundred trials or once in nine times. Therefore, the observed difference according to the general convention of interpreting the probability curve is statistically not significant. Of course, we must not forget that

TABLE 7

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 10-11 YEARS OF AGE.

Year	Boys					Girls				
	Number	Weight				Number	Weight			
		Range	Mean ± standard error	Standard deviation	Coefficient of variation		Range	Mean ± standard error	Standard deviation	Coefficient of variation
1933	224	40-114	68.50 ± .682	10.21	14.90	222	45-114	66.64 ± .780	11.62	17.44
1934	209	45-144	68.65 ± .788	11.39	16.59	217	40-134	66.37 ± .952	14.03	21.13
1935	254	40-129	67.97 ± .679	10.82	15.92	247	40-154	67.97 ± .935	14.70	21.63
1936	233	40-124	66.81 ± .606	9.25	13.85	248	40-154	68.45 ± .924	14.56	21.27
1921-27*	992		68.35 ± .344	10.84	15.86	925		67.49 ± .394	11.97	17.74

*Adjusted values, compare footnote to Table 3.

TABLE 8

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 11-12 YEARS OF AGE.

Year	Boys					Girls				
	Number	Weight				Number	Weight			
		Range	Mean ± standard error	Standard deviation	Coefficient of variation		Range	Mean ± standard error	Standard deviation	Coefficient of variation
1933	225	45-139	75.43 ± .804	12.07	16.00	242	45-144	76.51 ± 1.000	15.55	20.32
1934	220	45-129	74.80 ± .804	11.92	15.94	229	45-154	74.71 ± 1.013	15.34	20.53
1935	246	50-154	75.24 ± .770	12.08	16.05	231	45-159	75.53 ± 1.128	17.14	22.70
1936	259	45-139	74.55 ± .836	13.45	18.04	269	45-184	77.15 ± 1.123	18.42	23.88
1922-27*	868		75.22 ± .430	12.66	16.83	798		75.90 ± .524	14.79	19.49

*Adjusted values, compare footnote to Table 3.

these restrictions are nothing more than a statistical convention to exclude as much as possible the action of chance fluctuations. As large a difference as the above considered independently from its computed standard error, may have a thoroughly real meaning if confirmed by other observations of the same kind. The real significance of this difference is not yet definite in the present observation, especially since in the first year of the period, namely in 1933, the mean weights were considerably higher than in 1934. But altogether we might say that in the last years there has been in the older school girls a certain tendency to increase in weight.

In this age group, also, the girls are somewhat heavier than the boys, particularly in 1936. The variability of body weight shows exactly the same feature as in the younger age groups. Standard deviations and variation coefficients are distinctly larger for girls than for boys in all the calendar years; but only the variability constants of the girls in the period under observation 1933 to 1936 have increased considerably in comparison with the former period 1921-1927.

BOYS AND GIRLS 12-13 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 9)

In this age group of prepuberty there is for the first time in both sexes a parallel upward trend in the average weight. The increases are rather large, amounting to 4.59 pounds in boys and 5.16 pounds in girls (between the minimum and maximum values).

The question again arises: Are these increases in weight significant from the viewpoint of the chance theory? The highest and lowest means, their computed standard errors, and the differences may be given in a short summary:

	Boys		Girls
1936	84.04 $\pm$ 1.035 lbs.	1936	87.36 $\pm$ 1.221 lbs.
1933	79.45 $\pm$ 1.178 lbs.	1934	82.20 $\pm$ 1.243 lbs.
Difference	4.59 $\pm$ 1.568 lbs.		5.16 $\pm$ 1.742 lbs.

For each sex the increase in weight is almost exactly three times its standard error (2.93 times for boys and 2.96 times for girls) and therefore the increase in body weight is "significant" in the strict sense of the statistical theory. This finding seems to indicate that in 1935 and 1936 the children of this age group show a real increase of body weight in comparison with the years 1933 and 1934. Differences of this size would occur by chance alone only 3 times out of 1000.

It may be noticed further that the adjusted values of the combined years 1922-1927 are very close, especially in the case of the girls, to the observed mean weight of 1935 and 1936. Thus we may assume that there was a loss of weight in the years 1933 and 1934.

The girls in this age of prepuberty, 12-13 years of age, are through all the period of observation distinctly heavier than the boys. This corresponds to the sex differences in the general pattern of growth manifest in the years of "weight deficit" as well as in the "normal" years. The variability of body weight exhibits nearly the same trend as demonstrated before. Standard deviations and coefficients of variation are in

general higher for girls than for boys even if not as consistent as in the preceding age groups. When compared with the earlier period, 1922-1927, only the girls show in some years of the present investigation an increased variability, the boys not at all.

BOYS AND GIRLS 13-14 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 10)

It is clearly to be seen from the tabulated values that the general trend in this age group of beginning puberty is exactly the same as in the foregoing age group. The average weight went up considerably for both boys and girls. The year 1934 shows the lowest values. However, considering the comparatively small numbers and consequently high errors in 1933 and 1934, there is no real difference at all between these two years. But in 1935 there is a marked increase in the mean weight. This is true for both sexes. The increase of more than 6 pounds for girls and 8 pounds for boys is noted also in the following year of observation: 1936.

The exact differences between the highest and lowest values of the average weight are:

	Boys		Girls
1935	94.77 ± 1.100 lbs.	1936	98.08 ± 1.090 lbs.
1934	86.71 ± 2.253 lbs.	1934	91.94 ± 2.623 lbs.
Difference	8.06 ± 2.507 lbs.		6.14 ± 2.840 lbs.

There is no doubt that the increase in body weight of boys is significant in the strict sense of the chance theory, the difference being 3.21 its standard error. The difference for girls amounting to 2.16 its standard error characterizes the same upward trend and may, therefore, also indicate a significant increase in weight. The small number measured in 1934 and the high variability of the distribution gives a high standard error for this year and a large standard error of the difference. Altogether the upward trend for both sexes appears clear, it is the same as in the preceding age of prepuberty.

As compared with the adjusted mean weight for the former period, which comprises for this age only the years 1923-1927, it is again of interest that the values in 1933 and 1934 are distinctly below whereas the values in 1935 and 1936 are slightly above that average. Thus these consistent findings for the older school children in Hagerstown confirm or extend, indeed, Palmer's results on children 8-11 years of age insofar as there was in 1933 and 1934 a distinct drop of the mean body weight followed, however, by a still more striking rise in the immediately subsequent years 1935 and 1936. It will be of particular interest, in connection with this finding, to see what is the trend in the following years from 1937 on. Since this material is not yet fully available, it will be dealt with in another paper.

It is worth mentioning that in this group, 13-14 years of age, the girls were distinctly heavier than the boys in all the years of observation. The difference varies between 3 and 4 pounds in this age period of "filling out the figure." In contradistinction, however, with the results obtained for younger age groups, the variability of body weight

TABLE 9

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 12-13 YEARS OF AGE.

Year	Boys					Girls				
	Number	Weight				Number	Weight			
		Range	Mean ± standard error	Standard deviation	Coefficient of variation		Range	Mean ± standard error	Standard deviation	Coefficient of variation
1933	146	50-179	79.45 ± 1.178	14.23	17.91	143	45-154	82.71 ± 1.506	19.01	21.78
1934	159	50-159	80.96 ± 1.242	15.66	19.34	148	50-134	82.20 ± 1.243	15.13	18.40
1935	240	55-144	83.13 ± .918	14.22	17.10	257	50-149	86.02 ± 1.059	16.98	19.74
1936	231	50-189	84.04 ± 1.035	15.73	18.71	256	50-189	87.36 ± 1.221	19.54	22.37
1922-27*	681		82.67 ± .595	15.52	18.77	614		86.13 ± .664	16.46	19.11

*Adjusted values.

TABLE 10

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 13-14 YEARS OF AGE.

Year	Boys					Girls				
	Number	Weight				Number	Weight			
		Range	Mean ± standard error	Standard deviation	Coefficient of variation		Range	Mean ± standard error	Standard deviation	Coefficient of variation
1933	82	45-174	88.41 ± 2.260	20.47	23.15	56	60-154	92.86 ± 2.272	17.00	18.31
1934	76	60-199	86.71 ± 2.253	19.64	22.64	63	50-169	91.94 ± 2.623	20.82	22.64
1935	260	55-149	94.77 ± 1.100	17.74	18.72	294	55-184	97.99 ± 1.060	18.17	18.54
1936	249	55-169	94.25 ± 1.135	17.91	19.01	274	55-154	98.08 ± 1.090	18.05	18.40
1923-27*	466		92.57 ± .834	18.00	19.44	415		95.45 ± .862	17.56	18.40

*Adjusted values.

in girls is hardly any greater than for boys, and is moreover not consistently different in the years 1933 to 1936 from that observed in the former period 1923 to 1927.

BOYS AND GIRLS 14-15 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 11)

For this age there are only the measurements of three different generations (1934-1936) available because the material was originally collected for the purpose of making a longitudinal study of the same school children or school generations through the four calendar years 1933 to 1936. The eldest group dealt with in the first year of the observation, i.e., 1933, was 13 years of age and consequently only from 1934 are there observations on 14-year-old children. Similarly, only from 1935 are there observations on 15-year-old children. Of course, the age group 16-17 years is then represented only in one year: 1936.

For the boys 14-15 years old there was a very considerable increase of body weight during the three years; no real increase is noticeable for girls. For the boys the difference and its mean error between 1934 and 1936 amounts to as much as 16.11 $\pm$ 3.267 pounds. Beyond doubt such a difference is statistically significant being almost 5 times its standard error. If we compare the mean weights in the single years with the adjusted value of the former period 1924-1927, we recognize the same phenomenon as observed in the immediately preceding age groups. The low average body weight in 1934 of almost exactly 92 pounds denotes a decisive drop in comparison with more than 104 pounds, the adjusted value for the combined years 1924-1927. The latter value is somewhat surpassed in 1936 when the mean weight rose to 108 pounds. Thus the boys during the stage of adolescent acceleration in growth, which in general coincides with beginning of puberty, suffered in 1934 so far as body weight is concerned. Although in general a very variable factor in growth, body weight is likely to be also a fairly sensitive index in times of physical deterioration as is confirmed by individual and medical experience.

The phenomenon is different for girls, and the explanation for the different behavior in growth development during the period of observation is perhaps not quite easy. In fact there is no consistent or significant change in body weight at all, the averages being almost constant through this period and that of 1924-1927. Of course, the numbers examined in the year of 1934 are very small, n = 18 for girls and is smaller than that of the boys (n = 37). A large standard error results as may be seen in the table. Nevertheless, the average weights, independent from their respective errors, are so close in all the years under examination that it appears to be reasonable to look for some other explanation than chance alone. It may be found in the fact that at this age, 14-15 years, girls have almost completed their growth and filled out their figure. The annual increase in the following ages for girls, in contradistinction to boys, is only small as shown by the next tables. Hence it might have happened that already in 1934 the growth impulse caused by the earlier sexual maturity in the female sex was almost stabilized and was not affected by the environmental factors of deterioration.

Except in the year 1934, there is no distinct difference in the

TABLE 11

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 14-15 YEARS OF AGE.**

Year	Boys					Girls				
	Number	Weight				Number	Weight			
		Range	Mean ± standard error	Standard deviation	Coefficient of variation		Range	Mean ± standard error	Standard deviation	Coefficient of variation
1934	37	50-149	91.96 ± 2.959	18.00	19.57	18	50-164	103.61 ± 5.451	23.13	22.32
1935	148	65-139	102.47 ± 1.395	16.97	16.56	150	55-189	103.13 ± 1.630	19.96	19.35
1936	219	60-184	108.07 ± 1.384	20.48	18.95	290	60-189	105.07 ± 1.026	17.48	16.63
1924-27*	255		104.11 ± 1.108	17.70	17.00	220		104.02 ± 1.245	18.46	17.75

*Adjusted values.
**Comparable data for 1933 not available.

TABLE 12

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 15-16 YEARS OF AGE.**

Year	Boys					Girls				
	Number	Weight				Number	Weight			
		Range	Mean ± standard error	Standard deviation	Coefficient of variation		Range	Mean ± standard error	Standard deviation	Coefficient of variation
1935	88	65-189	113.64 ± 2.405	22.56	19.85	46	75-144	108.80 ± 2.171	14.72	13.53
1936	123	75-154	116.12 ± 1.581	17.53	15.10	134	60-199	106.98 ± 1.643	19.02	17.78
		Children 16-17 years of age.**								
1936	49	75-194	128.01 ± 3.276	22.93	17.91	33	75-149	112.65 ± 2.902	16.67	14.80

**Comparable data for the preceding years, 1933, 1934, 1935, respectively, and for the earlier period, 1921-1927, not available.

variations of body weight of boys and of girls. The variability constants, standard deviation and coefficient of variation are for all years in the same range. The same is true when they are compared with those of the former period of 1924-1927.

BOYS AND GIRLS 15-16 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 12)

In both the years 1935 and 1936 there is no significant change in the body weight, either for boys or for girls. This corresponds exactly to the findings in the younger age groups for these calendar years. Comparable data for the preceding years or for the former period 1921-1927 are not available.

It is remarkable, however, that at this age, 15-16 years - for the first time since tho beginning of the prepuberty stage - the boys considerably surpass the girls in average weight. The girls have almost stabilized their growth whereas the boys grow taller and, therefore, their body weight also increases. This well-known pattern of physical growth in the sexes is still more evident in the next age as the following data make clear.

BOYS AND GIRLS 16-17 YEARS OF AGE IN 1936 (Table 12)

For reasons explained above only one generation, the 13-year-old of 1933, is available at the age 16-17 years. Therefore a comparison of the weight constants with other generations in Hagerstown is not yet possible. However, the pattern of sex difference in favor of boys is more marked at this age. The mean body weight for boys amounts to 128.01 ± 3.276 pounds, for girls to 112.65 ± 2.902 pounds. The difference is more than 15 pounds. There is no doubt that this is a statistically significant deviation although the sample is small and therefore affected by a relatively high standard error. In this age, the variability constants are distinctly higher in the male sex, due to the greater vertical growth of male adolescents. It remains to be seen in a later survey how this pattern of average growth in weight compares with the development in height.

SUMMARY AND DISCUSSION

The material used in the present paper covers an extensive investigation on the growth of white school children of Hagerstown, Maryland, aged 6 to 16 years. It represents the first of a series of studies dealing with the pattern of growth and annual variations in the height and weight of children. The material was collected by the U. S. Public Health Service at Hagerstown during the years from 1933 through 1936 and represents to a certain degree the continuation of former studies on the growth of school children of the same community published in several papers by Palmer. Data regarding height and weight of these generations are available for three more years, 1937-1939, and will be presented in a later publication.

The observations used in this paper consist of the records of 14,401

weight measurements taken in May, 7,134 weights of boys and 7,267 of girls in the four successive years of the period. The number of observations varies in the successive years because from year to year one new generation of school children, 6 years of age, enters the investigation. The analysis of the data consists of the age and sex comparison of the average weights with their standard errors, the standard deviations and the coefficients of variation.

The principal results of the new Hagerstown growth study are illustrated in Figure 1 and may be summarized briefly as follows:

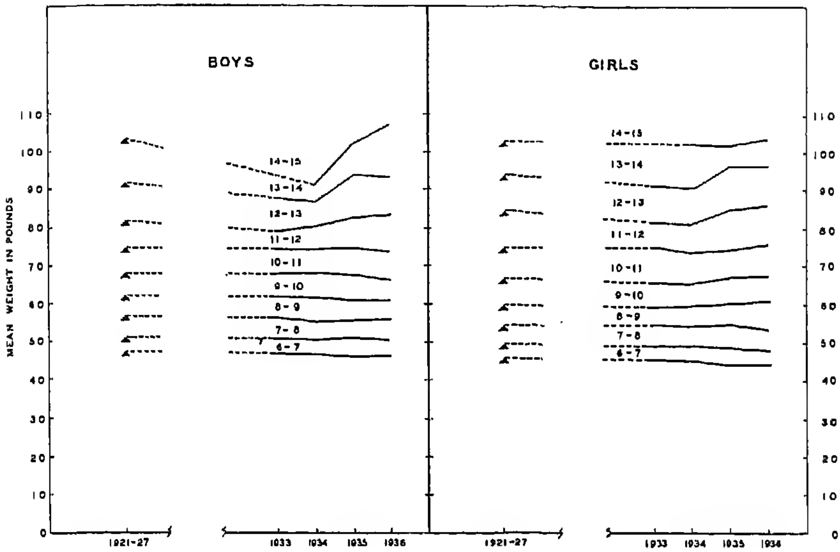

FIGURE 1

a) Boys and girls from 6 years of age (6 - 7 years) through 11 years of age (11 - 12 years) exhibit no consistent or statistically significant change in mean body weight during the single calendar years from 1933 to 1936. Also, when compared with the adjusted values of a period in the previous decade, the combined years 1921-1927, there is no essential or significant variation in body weight for these ages. The results are therefore in almost perfect agreement with Palmer's former findings on the white elementary school children 6-11 years old of this community. There occur some minor annual deviations in almost every age group, however, and the details are reported in the text and tables. There is, for instance, in the youngest age group, 6-7 years, a certain decrease of body weight noted in both sexes. However, it is not statistically significant. There is further for the ages 9-10 and 10-11 years a slight but consistent inverse trend in boys and girls to be mentioned; during the period of observation the mean body weight of the boys went down, that of the girls went up. Yet these differences, too, stay within the limits of chance fluctuations. Since the pattern of growth in boys and

girls is not yet fully developed, inverse trend during the same calendar years and similar economic conditions may be mentioned without giving too much emphasis to it.

b) The most striking result of this investigation is the fact that the older school children, boys and girls from 12 years of age and up, exhibit a statistically significant increase of mean body weight. The maximum annual increase for boys 12 years old amounts to 4.6 pounds and for girls 5.2 pounds. Considering the standard errors, differences of this size would occur by chance alone only 3 times out of 1000. There is little reason to doubt that such change in average body weight may have a real meaning, particularly when the same phenomenon of increase occurs in the next ages of prepuberty and beginning adolescence. In the age group 13-14 years, for boys the maximum annual increase amounts to 8.1 and for girls to 6.1 pounds in the period of observation. In the age 14-15 years, the maximum annual increase of body weight for boys amounts to as much as 16.1 pounds. This difference being nearly 5 times its standard error denotes that a real increase of body weight has taken place. The girls at this age have almost stabilized their growth and exhibit even in the succeeding ages of sexual maturity no more essential increase in weight growth. This sex difference in the change in weight will be left to be discussed later in connection with the variations of stature.

c) The phenomenon of a real increase in the body weight of the older school children in Hagerstown is perhaps more significant when the results from 1933 through 1936 are compared with the adjusted values of the former decade. So far as comparable data are available, namely for the 12, 13, and 14 years old children, the mean weights for 1933 and 1934 are distinctly below and those for 1935 and 1936 are somewhat above the average for the previous decade. This means that a distinct drop of body weight in the years 1933 and 1934 took place, followed soon, however, by a still more striking rise in the immediately subsequent years 1935 and 1936. Whatever the reasons (or our explanation) may be for this new finding, it will be of particular interest to watch the trend of growth in the following years from 1937 on.

d) The variability of body weight, as measured by the absolute parameter of standard deviation and the relative parameter of coefficient of variation, does not vary consistently in the single calendar years of the period under observation for the different age groups. Of course, the values go up with increasing age due to the steadily dispersing effect of growth. However, two points may be mentioned. First, the variability constants are almost in all age groups distinctly higher in girls than in boys. But more striking in this respect is that during the years of the present observation, 1933 to 1936, there is a distinctly greater variability of body weight in the girls than in the boys when compared to the former period 1921-1927. On the other hand, there is no correlation whatsoever between body weight itself and its variability constants in the four years. For instance, in the years 1933 and 1934 with low average weights the standard deviations are not consistently lower or higher than in 1935 and 1936. Thus it might be doubtful if the greater variability of girls in the later years has any other meaning than the expression of a sex character.

CONCLUSIONS

Body weight is certainly a highly variable element in growth since it depends on a series of constitutional and environmental factors. But it is also an index of periods of physical deterioration. The findings, that for the older school children of Hagerstown there was a distinct weight decline in 1933 and 1934 as compared with former and later years, extend the results of Palmer's study on younger children. Palmer's data showed, for the girls at least, a higher proportion of underweight individuals in 1933 and 1934 and, furthermore, a lower average annual gain in weight from May 1933 to May 1934 than in the earlier period 1921-1927, as a whole. The considerable increase in weight of the older children in the years from 1935 on are in fairly good agreement with the tendency to a general increase of growth observed all over the world and especially demonstrated for German school children after the last World War. The actual reasons for such a tendency are not yet clear. This trend may demonstrate the influence of various "growing" years or, more strictly speaking, the influence of varying natural and social environmental factors such as climate, hours of sunshine and rainfall, or the socio-economic characteristics of the years under observation. It may also be reasonable to suppose that such a world-wide socio-biological transformation as the general birth decrease in our time is indirectly involved in the growth phenomenon.

It remains to be seen by further investigation in Hagerstown if this tendency will continue. The behavior of the biological constants of growth in different calendar years may serve as an index of the varying socio-economics conditions. Thus from the standpoint of public health as well as of the physiology of growth further critical consideration and discussion of the possible factors involved are desirable on the basis of the new facts and figures in preparation.

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PIAGET'S QUESTIONS APPLIED TO ZUNI CHILDREN[1]

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INTRODUCTION

It is of utmost interest to determine whether the thought tendencies which have been investigated by Piaget are characteristic of children universally, or whether these tendencies are exhibited only in certain milieu. We are particularly concerned with the ideas which Piaget discussed in "The Child's Conception of the World" (3), namely, animism, realism and artificialism. Up to the present time the questions which Piaget reported in this important publication have been asked only of European and American white children. Mead's (2) report concerning the apparent lack of animism in Manus children of the Admiralty Islands does not constitute an exception to the above statement, since Mead did not employ Piaget's methods. It remains to be shown that Mead's techniques are adequate to reveal animistic tendencies in children. For this reason, we cannot agree with Mead that her results are at variance with those of the Genevan investigator.

In the summers of 1937, 1938 and 1940 we employed certain of Piaget's methods with some children who were attending the government day school in the farming village of Nutria on the Zuni Indian Reservation. The investigations of the first two summers were conducted by the senior author; those of the summer of 1940 were carried out by the junior author. The questioning was conducted in English, which is, of course, the language used in the school. Since the native language is spoken in the children's homes, and English is learned chiefly at school, no child was questioned unless he had been in attendance for at least two years and unless he showed an ability to name the objects about which our questions were asked.

In all, 24 children were examined, 15 boys and 9 girls, but not every one was examined with reference to each topic. On the other hand, some children were examined on the same topic in each of two or even all three summers. The number of children examined in reference to each topic will be reported in connection with the report of results. The subjects ranged in age from 8 to 16 years.

Prior to the examinations conducted by each investigator, he spent one or more days at the school as a visitor, playing with the children, speaking with them and gaining their confidence. Each investigator explained that he taught white boys and girls that he was anxious to become acquainted with Zuni children, and that he wanted to ask each of them some questions. The subjects were friendly, and rapport was good throughout. Each subject was examined individually in a room separated from the classroom.

[1]*This research has been made possible by grants-in-aid to the senior author on the part of the Social Science Research Council, whose support is gratefully acknowledged. Appreciation is also expressed to Mrs. Roy Poe and Mrs. Mary E. Sell, teachers at the Nutria Day School, for their willing cooperation.*

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ANIMISM

The topic of animism was the one on which the most time was spent. Questions concerning which items in a series of objects were living and which were dead were asked in each of the three visits to the school. In 1938 and in 1940, a procedure for the study of animism which we have described elsewhere (6) was employed. This method asks essentially the same questions as did Piaget, but it makes use of a standardized list of objects, selected because of their universality. In 1937, this procedure had not yet been adopted, but the questions asked were the same, and many of the objects used were the same, as those later employed.

In all 24 children between 8 and 16 years of age were examined with reference to animism. Some were examined during each of two summers, a few in all three summers. The total number of examinations was 37.

All of the answers which were obtained from the Zuni subjects were of the same types as those described by Piaget and which also were found in our studies of white American children. Typically, in Stage 1 the knife was living because it could cut, the button employed in the experiment was dead because it was broken, etc. In Stage 2, the motionless objects were said to be dead, but a watch, clouds, moon and the wind were alive because they moved. A pencil was living when the experimenter rolled it on the table but not when it lay still.

Illustrations of answers at the higher stages are few for Zuni subjects because only 4 of the 37 examinations were scored as being above Stage 1. Twenty-eight of the 37 were in Stage 1, while 5 subjects showed that they had no concept of living things.

While the number of subjects at any age level is too small to justify serious comparison with the white groups which we have studied (4), the evidence tends to show that the Indian children are retarded. Of the 33 examinations conducted with children under 13 years of age, 31 sets of answers revealed either "no concept" or Stage 1. In our experience with white groups of normal intelligence and of ages comparable to the Zuni children we have found no such preponderance of no concept and Stage 1 answers. However, the number of Zuni examinations is too few to permit a statement concerning the reliability of the difference.

With 13 subjects it was possible to compare records obtained in two different summers. Some of these records were separated by one year and others by two years. Eight of the 13 subjects showed no change, 3 subjects advanced one stage in the later test and 2 retrogressed one stage. There is no indication that these subjects, on the whole, were showing progressive changes in their concepts.

IDEAS OF CONSCIOUSNESS

In the summer of 1940, 14 subjects were questioned concerning the ability of each object in our standardized list to "feel" when it was touched. The question concerning the first eight objects was, "Does the ______ feel when I touch it?", the experimenter touching the object as he asked the question. The question was changed appropriately for objects not immediately present (5). Eight of the 14 subjects were in the no concept stage; that is, they answered at random or answered "yes" or "no"

uniformly in regard to all objects without respect to their condition or characteristics. Three subjects gave Stage 1 answers; that is, all objects which were useful and in good condition were said to be able to feel. Two subjects limited such consciousness to man, or to man and animals, and hence were classified as in the adult stage. No Stage 2 and Stage 3 answers were obtained. On the basis of the present evidence we cannot determine whether this fact was due to the small number of examinations or whether these stages do not occur in Zuni children. We suspect that the former interpretation is the correct one.

THE ORGAN OF THOUGHT

The questions concerning the remaining topics were asked only in the summer of 1937. They are taken from the examples of Piaget, and will be familiar to those who are acquainted with "The Child's Conception of the World." The chief difference between our method and that of Piaget lies in the fact that we attempted to ask the same questions of all subjects, and tried to use the same objects of reference in all cases, whereas Piaget varied his questions and interrogated one child about objects which were not referred to in the case of other subjects.

One group of queries asked in 1937 had to do with the organs by which various functions are performed. The initial questions were intended merely to establish rapport. They were, "What do you hear with?" "What do you see with?" "What do you run with?" These are answered by white children in a stereotyped manner and were answered in the same way by the Zuni subjects. Then each subject was asked the final question, "What do you think with?" to which Piaget has found that young children reply "with the mouth." Older subjects, of course, give the learned answer that it is done with the heart or the head.

Ten Zuni subjects, ranging in age from 8 to 13 years, were examined. Three gave no answer or else said they did not know. Two, however, one of eight and one of nine years of age, said thinking was done with the mouth. Three gave the learned answer that it is done with the heart or the head. One answered "the eyes" and one answered "arm." The latter was probably an anewer by analogy to the answers of the preceding questions; the other reply may also have been this, or it may have had reference to visual imagery in thinking. It is of interest that the answer given by Piaget's subjects also was given by Zuni subjects. However, most of the Zuni children were too old to lead one to expect them to give the childish conception.

DREAM REALISM

Each of 9 subjects was asked if he sometimes dreamed when he was asleep. After an affirmative answer was received, he was asked further, "Do you see your dreams or do you hear them or do you see and hear them?" Following this, Piaget's question relative to the location of dreams was put, "Where are they when you see them?" (or "when you hear them" according to the previous answer of the subject).

To this question 4 replied that they did not know; these subjects ranged in age from 8 to 13 years. Four, varying in age from 8 to 12

years, placed the dreams externally as did many of Piaget's subjects; only one subject gave the learned answer "in the head."

After this question, we followed Piaget's recommendation and suggested that dreams were in the head, excluding of course in this procedure the child who had already given this answer. Only one of the remaining eight accepted this suggestion; all the rest denied that our idea was correct. This, too, is in accord with Piaget's experience (3).

Then came the last inquiry concerning the objectivity of dreams: "If someone else were near you when you had a dream could he see or hear your dream?" Six of the nine subjects answered "Yes." This could not have been the result of a general tendency to give affirmative answers, since the immediately preceding question elicited predominantly negative replies.

ARTIFICIALISM

The last set of questions had to do with notions concerning the origin of a number of objects chosen so that they would be familiar to our subjects. In this instance we did not employ a rigidly standardized procedure but asked our questions variously in the following forms: "Where do we get ______ ?" "Where does ______ come from?" "How do we come to have ______ ?" An attempt was made throughout to make these questions real to the subjects and to interest them in solving these problems. Nine subjects were employed; these were the same nine children who have been referred to in the immediately preceding sections, and varied in age from 8 to 13 years as shown in Table 1.

TABLE 1

ORIGINS OF OBJECTS

	Origins								
Subject: Age:	Leo 8	Ant 9	Neil 9	Nal 9	Rac 10	Car 10	Jon 11	Jac 12	Lup 13
matches	store	store	made	store	store	store	made	store	store
clouds	d. k.	d. k.	rain	sky	sky	smoke	smoke	smoke	d. k.
coffee	store	store	flour	store	store	store	made	store	store
trees	hill	d. k.	ground	ground	ground	ground	ground	ground	ground
rain	sky	sky	sky	sky	clouds	clouds	sky	clouds	clouds
corn		fields	planted	planted	planted	planted	planted	planted	planted
cactus			God	ground	n. a.	ground	d. k.	ground	d. k.
hills	n. a.	d. k.	sand	n. a.	d. k.	grows	dust	d. k.	made
eggs		store	hen	hen	hen	hen	hen	hen	hen
shirts		store	store	made	store	store	city	store	store
rocks		ground	sand	ground	ground	brook	big rocks	ground	ground
sun		n. a.	of yellow	sky	sky	fire	sky	fire	d. k.
pencil		store	made	store	made	made	made	store	store
sky			d. k.	d. k.	d. k.	smoke	d. k.	heaven	d. k.
brook		d. k.	rain	d. k.	made	springs	rain	made	made
dam			made	d. k.	d. k.	made	made	made	d. k.
chicks		d. k.	eggs	eggs	store	eggs	eggs	eggs	d. k.
lambs		d. k.	God	mother	n. a.	mother	sheep	sheep	sheep
snakes		water	brooks	n. a.	n. a.	ground		rocks	d. k.

vers are shown in brief in Table 1. In this table "n. a." in-
; answered" and "d. k." denotes that the child said he did not

reveals a number of practical and common sense answers. All
ow that matches are made and come from a store. However, cof-
rise a store product. Trees, and corn and cactus, on the
are known to grow from the ground. Answers to a supplemen-
on as to whether these objects were planted by people (these
not shown in the table) revealed that all children knew that
planted, that trees were sometimes planted, but that cactus
nted. There were no artificialistic answers regarding the
ctus, although one might have expected such.
d to clouds and hills, some artificialistic and some natural-
es were evolved, and each answer was apparently an independent
Three Zuni children believed that clouds are due to smoke aris-
ves, a theory noted by Piaget. The others who answered the
d that the clouds came from the air, from the sky, etc.
ds were indirectly traceable to smoke in these instances was
ed.
gins for hills were recorded. Two subjects held that hills
dust and sand piled up by the wind, a process often observa-
outhwest. One girl claimed that hills grow from the ground.
d someone piled up the earth to make the hills.
d to the origin of rain, the usual answer was that it came
uds. Since the Zuni belief is that men can induce rain by
se of dances and other ceremonies, four of the initial an-
ollowed by a second question, "Can people make it rain?"
Zuni children held that people cannot make it rain. Only
adult reply, namely, that prayer sticks are effective agents
rain. This ignorance on the part of the children checks with
t of Zuni adults that ceremonies are seldom explained to the
il they are beyond twelve years of age.
ins of eggs, shirts, pencils, dams, chicks and lambs were in
ectly known. On the whole very few artificialistic answers
Brooks, however, were thought by three subjects to be man-
of the other answers, while superficially naturalistic, might
to be the result of an artificialistic interpretation had the
n followed up. However, in a few instances replies of a
tenor were pursued further with results consistently of a
alistic nature. For example, Neil, who said the sun was made
when asked suggestively if some person made it, said no.
r data are only indicative of a problem; we cannot attempt
comparisons of the artificialism of Zuni and white children
sufficient data relative to either are at hand. However,
it would appear that the Zuni subjects give fewer artificial-
s than do Piaget's subjects. If this proves to be the case
find its explanation in the fact that the Zuni child is more
iated with phenomena of generation and growth and much less
th articles of human manufacture. The meager material cul-
tive peoples may lead to a lesser degree of artificialism in
child.

DISCUSSION

The results here reported should be considered as the outcome of an exploratory investigation. They are not sufficiently numerous to enable one to make more than the roughest comparisons with data from white subjects. On the quantitative side, however, we cannot refrain from remarking that Piaget's data, no less than these, are insufficient for comparative purposes.

One question which demands serious attention is that of the language factor. The Zuni subjects are bilingual. English is merely an auxiliary language. Since the child first learns Zuni and continually uses it except when he is in school, it is altogether likely that he thinks in Zuni and does a considerable amount of translation in order to understand and to answer questions such as those here reported. In the course of this translation, much distortion of meaning may take place.

It would be most valuable could each investigation of child thought be conducted in the native language by someone thoroughly familiar with that language. This was out of the question in the present instance. However, in connection with the questions concerning animism, we attempted to familiarize ourselves with the Zuni concepts to which the child is exposed and to learn the Zuni words into which the child may have translated our question. In regard to the animistic use of language, the Zuni practice would seem to approximate our own. In referring to natural objects many anthropomorphic terms are used, terms which are comparable to our speaking of an angry cloud, a treacherous river, a fierce wind, etc. But in respect to the Zuni term which designates life or animation, ho'i, each of four native informants insisted that it is used just like our English term "living"; i.e., it is used only in reference to persons, animals and plants. The Zuni child's extension of the term to cover all useful and undamaged objects is wrong from the point of view of the Zuni adult, and is quite comparable to the tendencies of the white American and European child. Our informants flatly denied Bunzel's statement (1) that to the Zuni all objects are animated. Bunzel may, however, have been referring primarily to the Zuni's metaphorical use of anthropomorphic terms, although she mentions specifically the word ho'i about which we questioned our informants.

In addition to persons, animals and plants, the Zuni speak of supernatural beings as living; in that respect, also, their usage parallels ours.

SUMMARY

A considerable number of the questions employed by Piaget and reported in "The Child's Conception of the World" were put to some or all of 24 Zuni school children who ranged in age from 8 to 16 years. In regard to each topic, the answers obtained from the Zuni children comprised all or nearly all of the types described by Piaget; they are also like those recorded by ourselves in previous studies. No new types of answers were obtained. In other words, the conceptions of the Zuni child seem not to differ from those of Piaget's French-speaking and of our American subjects.

Whether there is a difference in the age-incidence of various answers

as between Zuni and European or American children cannot be said at the present time because the data are not sufficiently numerous. The data available suggest that Zuni children on the whole may persist longer in the first stage of animism than do white American children, but that the Zuni subjects develop fewer artificialistic notions or else forsake them at an earlier age. If these differences prove to be real, they may be the result of specific environmental factors rather than representing a general difference between primitive and civilized children.

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APPARATUS FOR MEASURING OXYGEN CONSUMPTION IN HUMAN SUBJECTS AT REST AND AFTER EXERCISE

NATHAN W. SHOCK, ERIC OGDEN AND P. M. TUTTLE[1]

In a long term study of adolescence undertaken by the Institute of Child Welfare, particular interest was centered on the relation between physiological homeostasis and maturity and hence an intensive study of physiological readjustments following displacing stimuli was made. A study of the recovery of oxygen consumption after severe exercise was included as one index of homeostasis. For the collection of data adequate for estimating rate of change in oxygen consumption after exercise the following apparatus was designed and constructed.

The apparatus to be described offers definite advantages over any previously used in that it provides for continuous determinations of oxygen consumption over successive periods, the duration of which may be varied. The method is essentially a combination of the methods of Tissot (3) and of Hill (1,2) and involves the collection of expired air in one of a pair of Tissot spirometers, while the air expired during the previous period is being measured, sampled, and discarded from the other.

To insure the flexibility necessary for the collection of small samples in rapidly changing conditions without the necessity of making an inordinately large number of analyses in experiments of longer duration, two pairs of spirometers were used, a large pair for the longer periods and a smaller pair either alone or in conjunction with the larger pair for short or intermediate periods.

TWO LARGE SPIROMETERS

Two large spirometers (A and B, Figs. 1 and 2) were used primarily for the collection of expired air during periods of basal determination or other stable circumstances where relatively long periods of air collection were desired.

When expired air was to be collected in the large spirometers (A and B) the flexible rubber hose from the mercury expiratory valve (W) was connected to the opening of the T-valve (G) (the arrangement shown in Fig. 2 is different and is discussed later) which was turned so that the expired air passed directly through a one-inch pipe into a one and one-half inch T-valve (C), which directed it through a one and one-half inch pipe, past one or the other of the T-joints on which were situated the discharge valves O and N respectively, into the large fifty-liter spirometer (A or B). These spirometers which had a full range of movement of 55 cm. had a factor of 0.871 L/cm. at S.T.P. The dead space between the valve (C) and the bell was 1.25 liters. The spirometer tanks had concentrically placed drums to minimize the water surface exposed to the air within them. Each spirometer carried a thermometer (P) and a stirrup which was attached by a chain to a counterbalance. The weight of the

[1]From the Institute of Child Welfare and the Division of Physiology Medical School, University of California.

Grateful acknowledgment is made to the Work Projects Administration (O.P. No. 665-08-3-30, Unit A-8) for assistance in the construction of this apparatus.

CHILD DEVELOPMENT, Vol. 11, No. 3 (September, 1940)

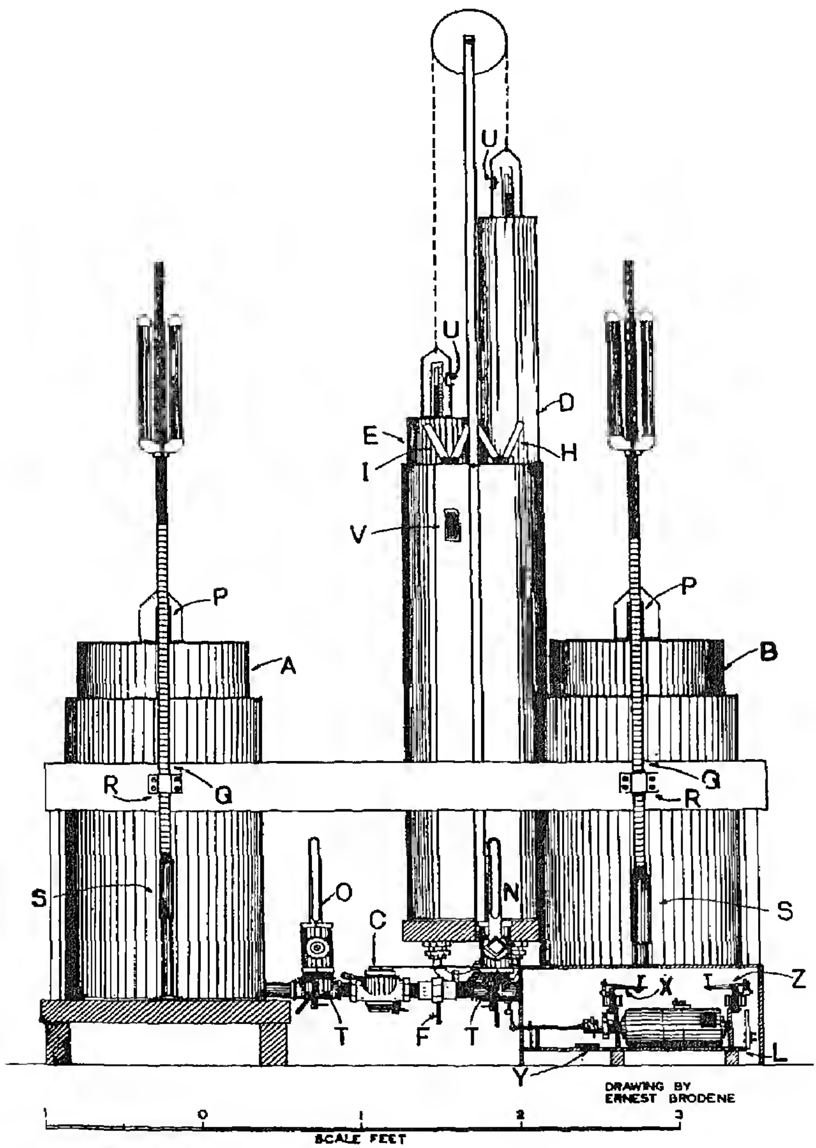

Fig. 1. View of apparatus from operator's side showing contacts and motor for automatic change-over for small 9.19 liter spirometers.

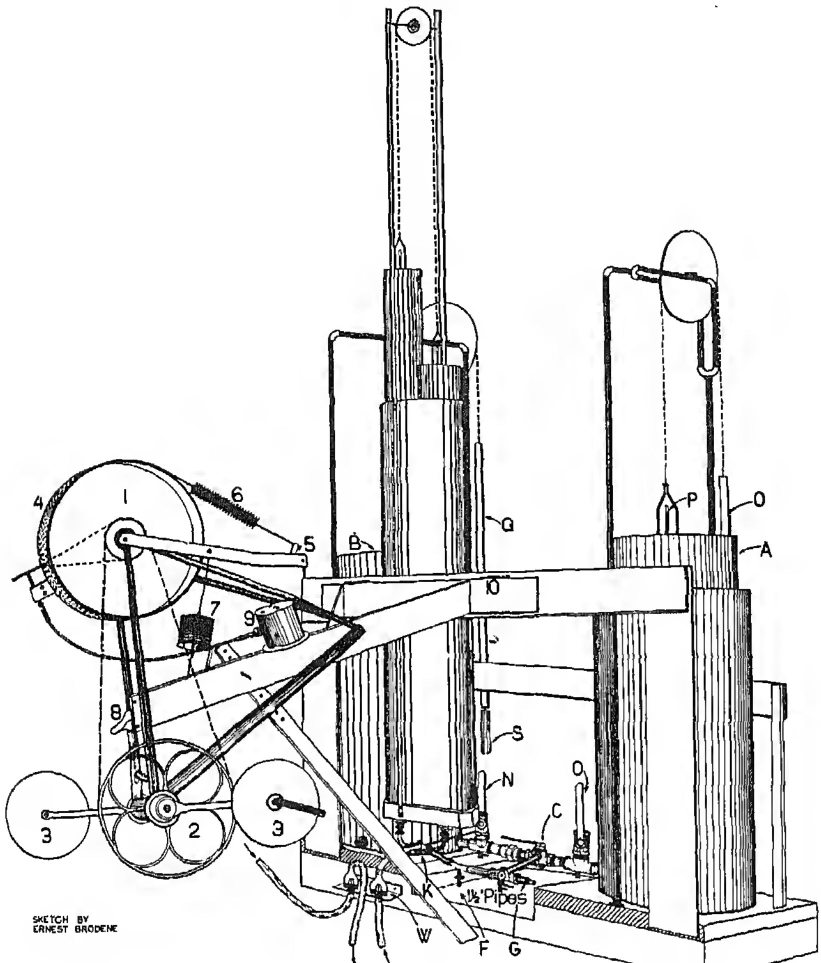

Fig. 2. Front view of apparatus with bicycle ergometer in position for arm exercise.

chain was calculated to compensate exactly for the change in weight of the spirometer as it rose out of the water. The total friction at the pulley was such that an excess weight of 5 gm. caused the bell of these spirometers to fall. Readings were made from the moving meter-scale (Q) to the stationary zero mark (R).

At the end of the collection, the stop-cock (C) was turned, directing the stream of air into the other spirometer; and after readings of volume and temperature had been made, the counterbalance (S) was unhooked, and the stop-cock (N or O) opened to the atmosphere. When the spirometer was

half discharged the stop-cock (N or O) was closed while a sample of gas for analysis was withdrawn from the sample cock (T). A series of samples taken at 10 cm. intervals between complete fullness and complete emptiness indicated that mixing within the spirometers was adequate (Table 1). When the sampling was finished the spirometer was completely emptied, the discharge valve (N or O) closed, and the spirometer was ready for the next collection. In practice, it was found possible to take the readings and sample and to empty the spirometer completely, so that it would be ready in one minute from the time the collection was completed.

TABLE 1

SAMPLING ERROR OF GAS CONTENTS OF SPIROMETER

Spirometer Reading Cm.	CO_2 Analysis		O_2 Analysis	
	I	II	I	II
50.0	3.142	3.147	17.24	17.22
40.0	3.157	3.157	17.20	17.20
33.0	3.151	3.176	17.19	17.21
26.0	3.118	3.155	17.16	17.13
20.0	3.120	3.140	17.19	17.19
13.0	3.165	3.165	17.23	17.24
8.0	3.146	3.149	17.22	17.23
2.0	3.147	3.150	17.26	17.25

SMALL TWIN SPIROMETERS

Two small aluminum spirometers of 9.19 liters capacity (D and E, Fig. 1) were used for rapid measurement of small volumes of expired air. These were suspended in the same tank and so connected over a pulley that each formed a counterbalance for the other at all positions. The dimensions were approximately 15 by 100 centimeters. The full range of movement was about 60 cm. In order to use these spirometers, the flexible rubber tubing from the expiratory valve (W) (Fig. 2) was connected to the inlet part of a four-way valve (K) (Figs. 2 and 3). Air passed through the double two-way valve (K) (Figs. 2 and 3) into one of the spirometers (D), which rose as more air entered. As it rose, the other spirometer (E) fell, driving its contents through the other passageway in the double two-way valve (K) and out by way of the hand-operated T-valve (G) to the atmosphere. During this discharge of air, a sample was taken from the small side tube (F), which was ordinarily closed with a pinch-clamp. As the spirometer (E) became completely emptied the brass bar (U) (Fig. 1) on the top of this spirometer bell closed an electrical circuit across the open contact slot (I). This was in circuit with the relay (X) which momentarily closed a circuit that energized motor (L) which immediately turned the double two-way valve (K) in such a way that the incoming stream of air was directed to the other spirometer (E), and the outgoing stream of air from the full spirometer (D). The motor ran only momentarily, since, when the shaft had turned three-quarters of a revolution, sufficient to change the position of valve (K), a contact (Y) was made which broke the current to the motor through relay (Z). A signal magnet operating on a moving paper kymograph was actuated at the end of each

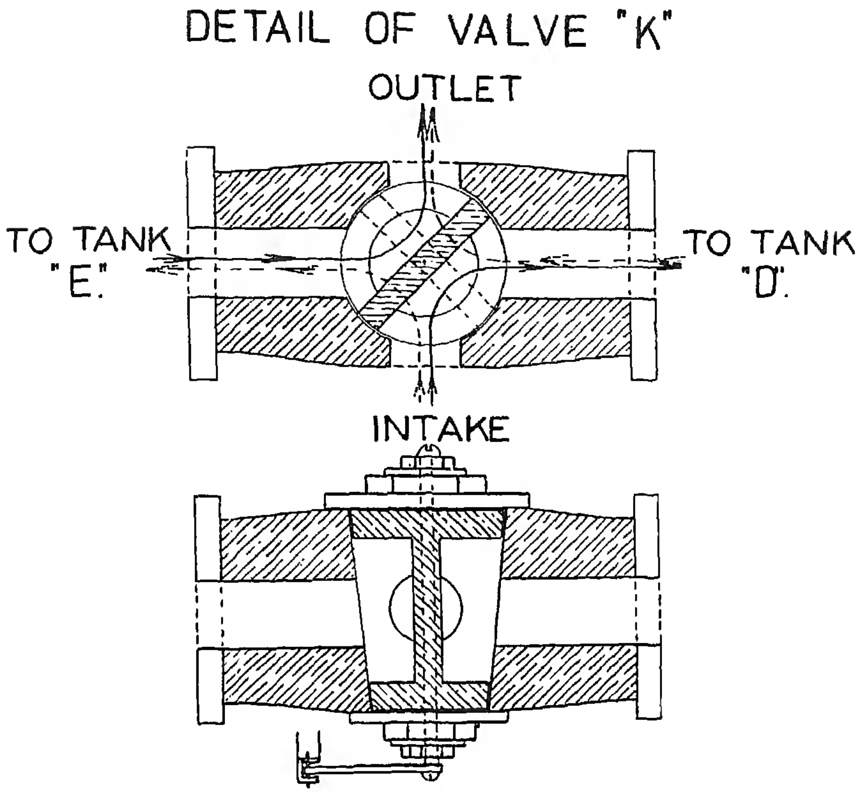

Fig. 3. Detail of motor driven automatic change-over valve (K) leading to and from 9.19 liter spirometers.

collection of 9.19 liters. While the previously collected 9.19 liters was being discharged, samples of it were taken for gas analysis. If the air was coming so quickly that there was not time to take a sample from each 9.19 liters, or if the experiment was to continue so long and conditions were changing so slowly that it would be uselessly laborious to make an analysis from each 9.19 liters, the T-valve (G) was so set that, instead of discharging into the atmosphere, the 9.19-liter spirometer discharged into either of the previously described pair of 50-liter spirometers. In these, any given number of 9.19-liter samples (up to five) could be stored, mixed, and sampled at leisure.

Figure 4 is a circuit diagram to indicate the arrangements whereby the filling of each spirometer provided for its own emptying and for the filling of the other. It illustrates also the mechanism by which the starting of the paper polygraph was synchronized with the beginning of the collection of the first sample of expired air. No movement of the

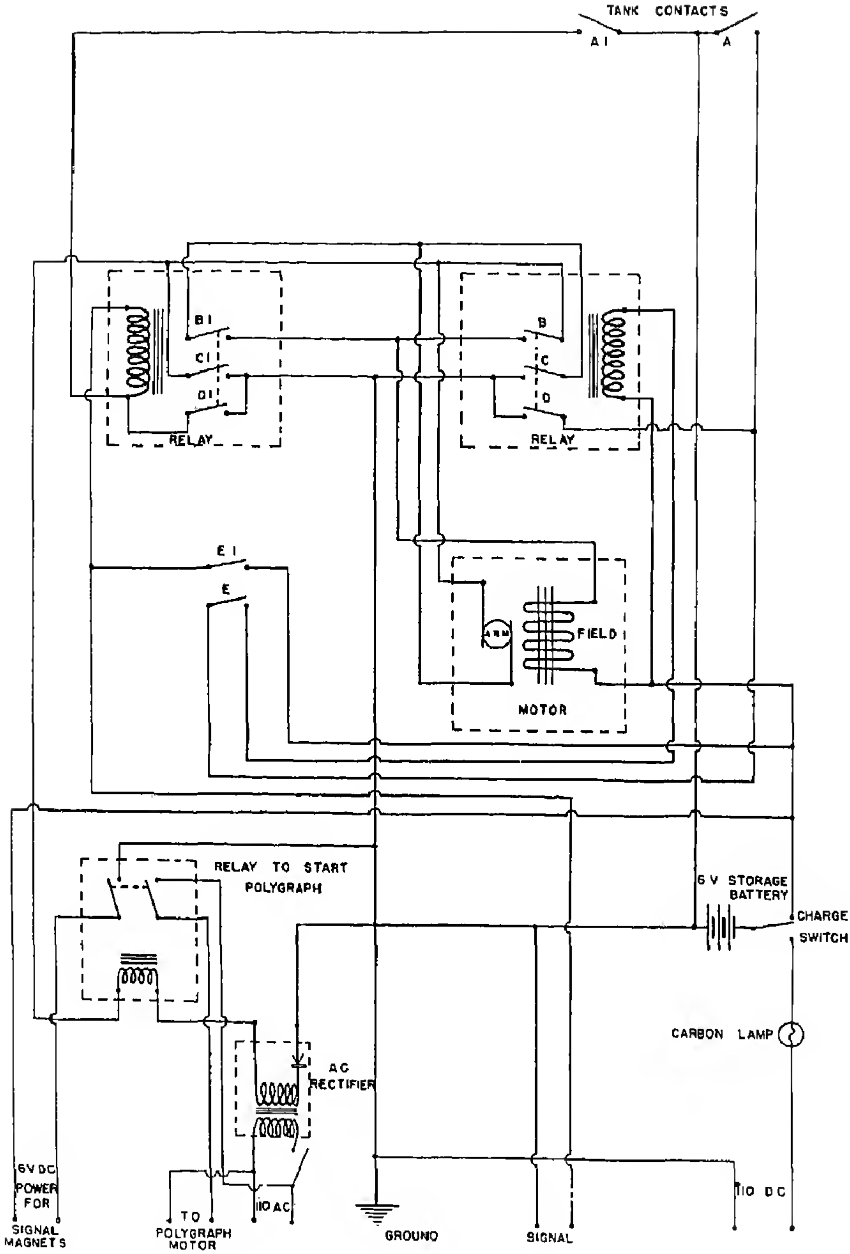

Fig. 4. Wiring diagram of contacts, relays and motor driving the automatic change-over valve for the 9.19 liter spirometers.

valve motor is initiated by contacts A and A', which are attached to the tanks. Closure of either of these contacts operated the corresponding relay. Contacts B and C, and B' and C', started the motor and controlled its direction. Contacts D and D' were provided to keep the relay closed until the valve change was completed. Contacts E and E' stopped the motor at the end of the valve change. These contacts were held closed by springs, and one or the other was caused to open by the valve-changing motor at the end of the valve rotation.

ERGOMETER

In order to provide facilities for varying the oxygen utilization, a bicycle ergometer was arranged so that the subject might operate it with his hands while lying supine by the metabolism apparatus.

The ergometer was hinged (10) (Fig. 2) so that it could be swung up out of the way. When in use it was supported by a pin and perforated brace (below numerals 7 and 9 diagonally down to the right), the different perforations allowing adjustment for individual convenience.

The pedals were removed and hand guards (3) provided to prevent the hands from getting between the chain and the large sprocket (2). Load was provided by a brake drum and band (4) held by a spring (6) adjustable by a wing screw (5) to a bar anchored down by a metal sylphon tambour (7). Traction on the drum, tending to raise the bar (5), stretched the tambour which, in turn, pneumatically actuated a similar metal tambour writing on the paper polygraph a record of the tension. At each revolution one pedal closed the flexible brass contacts (8), recording on the polygraph the number of revolutions. Thus there was an automatic record of the number of revolutions per minute and of the tension against which these were made.

An automobile speedometer (9) gave the subject a visual opportunity to check the constancy of his rate of doing work, and was used to provide an urge to maximal or sustained activity. A sample of the record obtained from the paper polygraph in a typical experiment is shown in Fig. 5.

CALIBRATION OF ERGOMETER[2]

In order to determine the amount of work done in turning the crank of the ergometer at different tensions of the brake drum, the following experiments were performed. The shaft of an electric motor was attached directly to the shaft of the large sprocket (A, Fig. 6). The frame of the motor was suspended between two bearings and was thus free to rotate. A lower arm (L') was attached to the motor frame and rested on a balance. Thus it was possible to measure the torque on the motor armature by reading the balance attached to the motor frame through lever L'. The force exerted at each degree of tension of the ergometer drum was measured on a balance (F', Fig. 6) through the lever arm L' (Fig. 6). (This lever arm was actually attached to the frame of the driving motor, but for convenience of illustration is shown as attached to the driving sprocket

[2]*Our thanks are due to Prof. R. G. Folsom, of the Department of Mechanical Engineering, for advice and assistance, as well as the loan of equipment in making the calibration curve for the ergometer.*

wheel of the ergometer.) The force F' was measured to $\pm$ .01 pound. From the data obtained it is possible to compute the work done as follows:

$$W = F\ S$$

Where W = work in Kg.m.; F = force in Kg.; S = distance in M.

$$\frac{F}{F'} = \frac{L'}{L}$$

Where F = force exerted on ergometer crank; F' = force registered on balance attached to dynamometer lever; L = length of ergometer crank arm; and L' = length of dynamometer arm.

$$F = \frac{F'L'}{L}$$

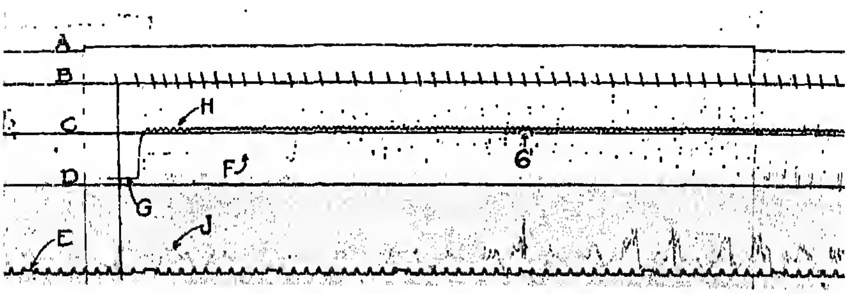

Fig. 5. Sample polygraph record obtained during arm exercise experiment. Record reads from left to right. Signal magnet A indicates time at which small 9.19 liter spirometer began to fill - next mark on this line indicates the end of the collection of 9.19 liters of expired air.

B - Each mark indicates one revolution of the ergometer crank.

C - Time line, marking minutes (6' marked) from beginning of experiment.

D - Signal marker to indicate time at which systolic and diastolic blood pressure were read (no pressures could be read during the exercise, but the first reading was made within 10 seconds of the conclusion of the exercise).

E - Time line, marked in seconds.

F - Continuous record of pulse rate obtained from pneumatic cuff attached to subject's ankle and inflated to 50 - 60 mm.Hg; recorded pneumatically through metal tambour.

G - Base line for recording tension on ergometer.

H - Line showing setting of friction brake on ergometer, pneumatically recorded through metal tambours connected with copper tubing.

J - Respiration curve, pneumatically recorded through pneumograph around thorax.

Since the motion is rotary, the distance traversed is

$$S = 2\pi L n$$

Where n = number of revolutions of the crank

$$W = \frac{F'L'}{L} \times 2\pi L n$$

$$= 2\pi L' \times F' \times n$$

Since L' = 32 cm. it is possible to calculate the amount of work done.

Table 2 shows the values obtained for F' at different tensions on the drum expressed in terms of the height of the curve from the polygraph record (see Fig. 5).

The values for $2\pi L'$ (or work in Kg.m. per revolutions of the crank) are placed against the height of the polygraph curve (in mm.) in Fig. 7.

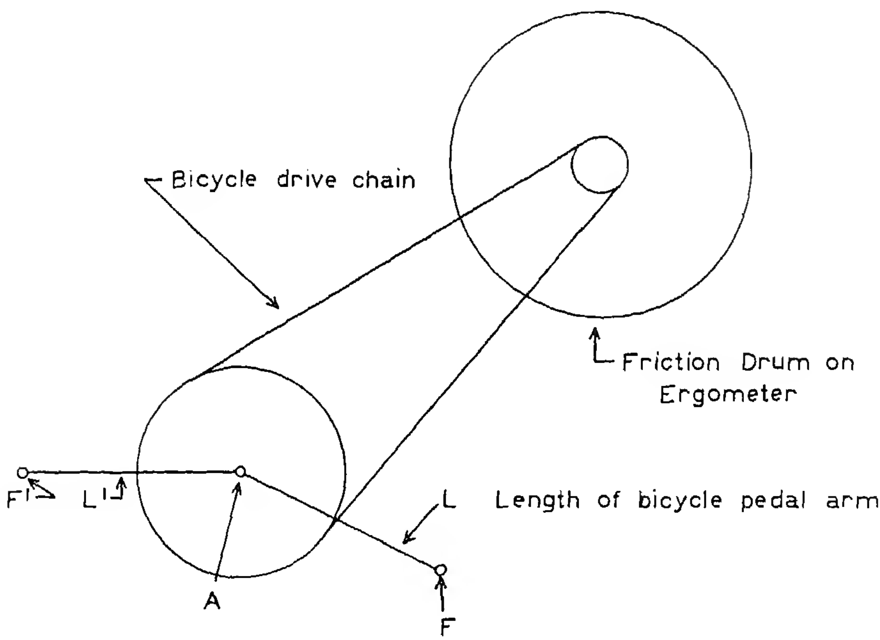

Fig. 6. Diagram of method used to obtain dynamic calibration of bicycle ergometer.

L - Length of bicycle pedal arm.

L' - Length of lever arm attached to frame of motor at one end (A) and to balance at other end (F') to measure torque exerted by motor.

F - Force applied to bicycle pedal by subject.

F' - Force exerted by motor (measured on balance).

TABLE 2

DATA FOR CALIBRATION OF ERGOMETER

Test No.	Height of Curve mm.	Height of Base Line m.	H. (Col.2 - Col.3)	F' (Lbs.)	2 F'L' (Kg.M.)*
1	2	3	4	5	6
1	42.5	32.1	10.4	2.50	2.281
2	42.5	32.1	10.4	2.48	2.264
3	36.2	31.9	4.3	1.23	1.123
4	36.0	31.7	4.3	1.23	1.123
5	35.5	30.9	4.6	1.20	1.097
6	35.5	30.9	4.6	1.20	1.097
7	35.5	30.9	4.6	1.20	1.097
8	35.5	30.9	4.6	1.20	1.097
9	35.5	30.9	4.6	1.28	1.170
10	35.8	30.9	4.9	1.33	1.215
11	35.5	30.9	4.6	1.21	1.105
12	40.5	30.9	9.6	2.38	2.175
13	40.0	30.9	9.1	2.30	2.100
14	39.5	30.9	8.6	2.10	1.919
15	38.8	30.9	7.9	2.00	1.827
16	38.5	30.9	7.6	1.95	1.780
17	42.2	30.9	11.3	2.65	2.420
18	42.0	30.9	11.1	2.65	2.420
19	45.5	30.9	14.6	3.32	3.038
20	45.5	30.9	14.6	3.38	3.085
21	45.5	30.9	14.6	3.40	3.105
22	55.7	31.0	24.7	5.40	4.940
23	55.0	30.5	24.5	5.37	4.900
24	62.0	30.6	31.4	6.72	6.135
25	61.6	30.0	31.6	6.70	6.120
26	33.1	29.3	3.8	1.02	.932
27	33.0	29.3	3.7	1.00	.913
28	46.5	29.7	16.8	3.68	3.360
29	46.3	29.7	16.6	3.70	3.380
30	42.0	29.7	12.3	2.85	2.600
31	41.4	29.7	11.7	2.73	2.493
32	40.5	29.7	10.8	2.62	2.390

*Note: Column 6. L', the dynamometer lever arm, is 32 cm. long

$$2\ F'L'_{(Kg.M.)} = F'_{(Lbs.)} \times 2 \times 454\ g/lb. \times 32\ cm. \times 10^{-5}$$

Examination of this plot shows it to be approximately linear. The equation of the best fitting line to this series of points is

$$W = 0.182\ h. + 0.38$$

where W = work per revolution in Kg.m., and h. = height of polygraph curve in mm. From this equation it is possible to compute the amount of work done from the polygraph record which shows the tension on the drum (height of curve H, Fig. 5) and the number of revolutions as well as the duration of the exercise. Change in the tension which may result from rise in temperature of the brake drum will be recorded by changes in the height of the polygraph curve so that an accurate record of work done is obtained.

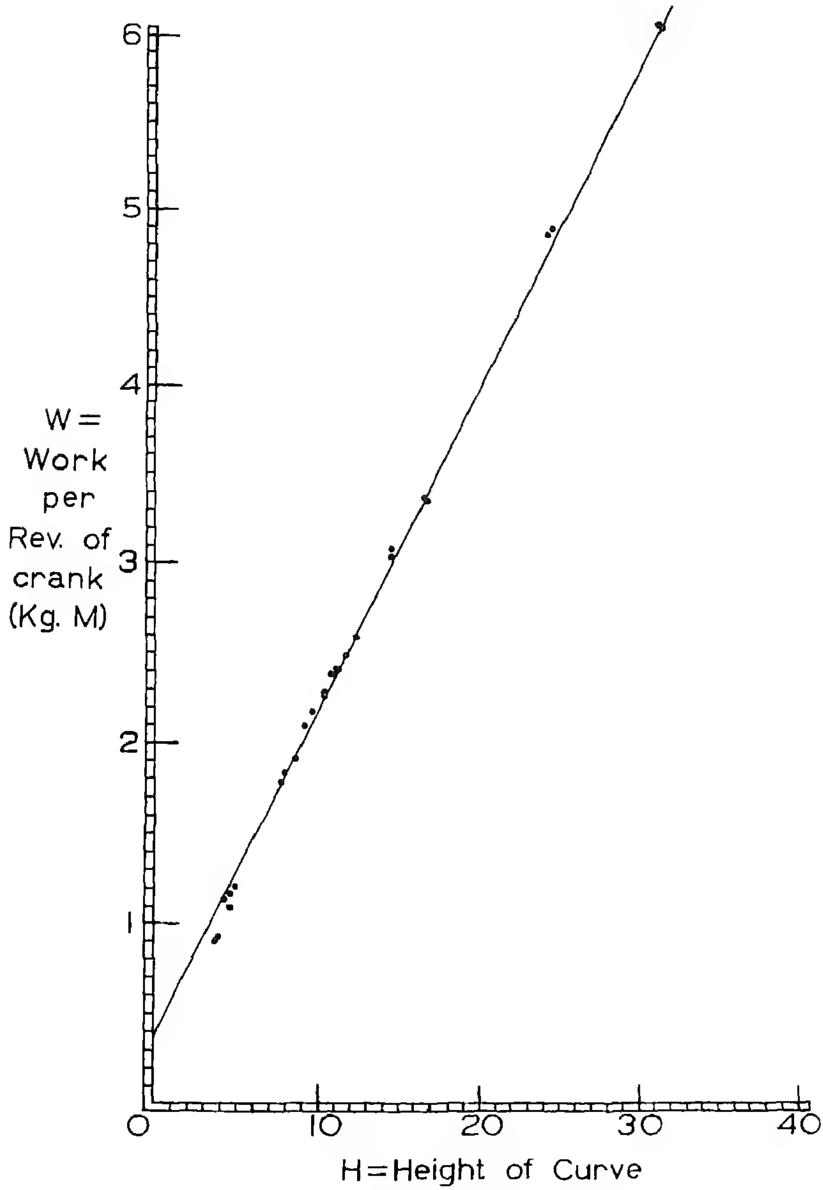

Fig. 7. Calibration curve of ergometer, showing experimental determination of work required per revolution of the pedal arm at increasing tensions on the friction drum as measured by increasing height of curve from sylphon tambours recorded on polygraph roll (distance from G to H in mm. on Figure 5). Best fitting equation to the line shown is Work per revolution of crank (Kg. m.) = 0.182 H + 0.38, where H is the height of the polygraph curve in mm.

EXPERIMENTAL RESULTS OBTAINED

Tests were run on a group of 50 girls and 50 boys at six-month intervals between the ages of 13 and 17 years, in connection with the Adolescent Study at the Institute of Child Welfare.

Figure 8 shows the results obtained in a single exercise experiment obtained with the apparatus described. The curve for oxygen consumption is plotted in terms of cc. O_2 taken up per minute per kg. body weight and also as percentage deviation from the basal level determined before the start of exercise. Curves for pulse rate, blood pressure, and respiratory volume are also shown. In this experiment the period of increasing oxygen uptake at the beginning of the exercise is shown as well as the period of recovery. A study of age changes in recovery rate is being made from such data.

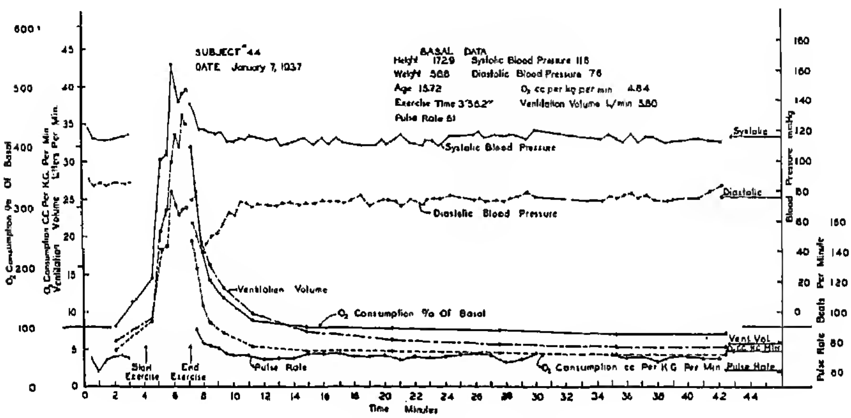

Fig. 8. Sample plot of arm exercise experiments.

Subject No. 44 - January 7, 1937.

Basal data: Height 172.9 cm.; Weight 56.8 kg.; Age 15.72 years; Systolic blood pressure 116 mm. Hg.; Diastolic blood pressure 76 mm. Hg.; Pulse rate 61 per minute; Basal O_2 consumption 4.84 cc. O_2 per kg. per minute; Ventilation volume 5.80 liters per minute.

Time of exercise - 3' 56.2"
Total work done - 992.6 kg. m.
Rate of work - 251 kg. m. per minute

Curves show:

•—•—•—•—•—•	Systolic blood pressure
•---•---•---•---•---•	Diastolic blood pressure
o————o————o	Oxygen consumption % of basal
o—— - ——o—— -	Ventilation volume L./min.
o-----o-----o-----o----	Oxygen consumption - cc./kg./min.
o —— o —— o ——	Pulse rate

Basal values plotted at arrows at right.
Curves show physiological displacements during and after exercise.

SUMMARY

An apparatus is described for obtaining continuous samples of expired air at rest or after exercise and for measuring respiratory volume.

An ergometer is described which can be used for the performance of variable measured amounts of arm work by a subject in the supine position.

A calibration curve for the ergometer is presented.

Sample records obtained with the apparatus are shown.

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(3) Tissot, J.: Nouvelle methode de mesure et d'inscription du debit et des mouvements respiratoires de l'homme et des animaux. J. de Physiol., 1904, 6, 688-700.

THE SCHOOL LUNCH AS A SUPPLEMENT TO THE HOME DIET OF GRADE SCHOOL CHILDREN[1]

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Interest is general in the possibility of improving the nutritional status of grade-school children by mid-day or mid-session feeding at school. For this reason, the study described in this report was conducted to find whether or not it might be possible to supplement the morning and evening home meals of representative children in different socio-economic groups in such a way as to bring the day's intake up to a desirable standard.

The problem was undertaken in the following manner:

(1) A series of nutrition tests was given to each of 225 children representing a wide range of family cash income; these tests included:
   - (a) nutritional rating from a physical examination given by a pediatrician;
   - (b) weight status;
   - (c) skeletal status including a maturity assay and a mineralization index;
   - (d) dental status;
   - (e) slump;
   - (f) plantar contact;
   - (g) darkness adaptation response;
   - (h) hemoglobin status; and
   - (i) capillary wall strength.

(2) A one-week dietary was kept for each child.

(3) From the responses to the tests and the results of the dietary calculations, recommendations are made concerning the kind and amount of nutrient factors which should be included in the diets given at school to children of different socio-economic groups, so as to supplement the morning and evening meals likely to be received at home.

[1] *A joint contribution from The Pennsylvania State College and the Department of Health of the Commonwealth of Pennsylvania.*

Authorized August 29, 1940 as Paper Number 6 in the Human Nutrition Research Series of the Division of Home Economics Research, The Pennsylvania State College.

The authors are indebted to Sophronia R. House for invaluable aid in tabulating data.

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METHODS OF PROCEDURE

SUBJECTS OF THE STUDY

For the study, 225 children, including 102 males and 123 females, were selected from two non-metropolitan urban communities in which children were being tested for nutritional status and dietary habits in connection with a long-time program of research carried on jointly by the Department of Health of the Commonwealth of Pennsylvania and the Division of Home Economics Research at The Pennsylvania State College. The children for this aspect of the larger nutritional study were chosen from the two communities in such a way as to represent the family cash income distribution of the school children in the combined communities as a whole. On the basis of cash income, following the arbitrary income grouping described by Mack and Smith (8), the children in the present study were distributed as follows:

31 in Income Classes A and B combined, representing families with annual cash incomes of $2500 and above;
101 in Income Class C, representing families with incomes of $2499 to $1000;
56 in Income Class D, representing families with incomes below $1000 but not on direct governmental relief; and
37 from families which were on direct governmental relief at the time when the measurements were made.

Although the basis for the selection of the children for this investigation was family annual cash income, the education of the adults in the families, as well as a rating of their physical homes were obtained from home visits by registered nurses associated with the study, and the responses of the children to the nutritional tests as well as their intake of the various nutrients were averaged on the basis of family education and of physical home rating, as well as of family cash income. The rating schemes for family cash income, family education, and physical home score were those described by Mack and Smith (8), as follows:

"Family cash income is rated according to an arbitrary scale as follows:

Class	A-1,	$10,000 or above
	A-2,	7,500 to 9,999, inclusive
	A-3,	5,000 to 7,499, inclusive
Class	B-1,	4,000 to 4,999, inclusive
	B-2,	3,000 to 3,999, inclusive
	B-3,	2,500 to 2,999, inclusive
Class	C-1,	2,000 to 2,499, inclusive
	C-2,	1,500 to 1,999, inclusive
	C-3,	1,000 to 1,499, inclusive

Class D, Incomes below $1,000.00, exclusive of families on direct relief.

Class E, Income of families on direct relief alone."

"The educational level of a family is rated arbitrarily according to the education of adult members, which are defined to include all persons of 19 years of age or over, except those who are still continuing their education. The rating scale is as follows:

Class A, All adults college graduates;
Class B, One member of the family a college graduate;
Class C, All adults high school graduates;
Class D, One member of the family a high school graduate;
Class E, No member of the family a high school graduate."

"In devising an arbitrary 100-point system for grading a home as to its physical characteristics, the home was regarded as a place in which the family eats and sleeps, and in which there should be adequate provision for rest, recreation, the preparation and consumption of food, and group social life. The rating system used was intended to give credit to those features in the home which are believed to influence the general well-being of the family members, particularly as regards nutritional status. The data sheet used in making physical home evaluations is the following:

SIZE OF HOUSE: (Number of Rooms ___) - 12 points . . . . . ___
(Note whether or not there are roomers, and how many) ___

FURNITURE:
10 points for entirely adequate furniture (in good condition) for the size of the house; number of points adjusted downward at discretion of grader; 6 points is the maximum to be given if furniture is adequate, but not in good condition . . . . ___

CLEANLINESS OF INTERIOR:
10 points if interior is immaculate in every detail; number of points to be adjusted downward at the discretion of the grader . . . . ___

POSSESSION OF A CENTRAL HEATING PLANT: - Maximum 10 points ___

POSSESSION OF CONVENIENT COOKING EQUIPMENT: - Maximum 5 points. . . . . ___

POSSESSION OF SATISFACTORY REFRIGERATOR: - Maximum 5 points ___

POSSESSION OF A WORTHWHILE MUSICAL INSTRUMENT: - Maximum 5 points. . . . . ___

ORNAMENTATION WITHIN THE HOUSE: - Maximum 5 points . . . . ___

PROVISION FOR REST:
<u>For Child</u> - Sleeps alone - 8 points . . . . ___
Sleeps with one other child - 7 points . . . . ___
Sleeps with one adult - 6 points . . . . ___
Sleeps with two other children - 4 points . . . . ___
Sleeps with two adults, or three other children - 1 point . . . . ___
<u>For Adult</u> - Maximum 8 points, depending upon adequacy of provision for rest . . . . ___

(Note: Each individual is rated, and the average taken as the rating of the home on this point.)

Average . . . . ___

EXTERIOR OF HOUSE WELL KEPT: - Maximum 10 points . . . . . ___

PROVISION FOR RECREATION: - Maximum 10 points . . . . ___

POSSESSION OF GRASS AND FLOWERS: - Maximum 5 points . . . . ___

POSSESSION OF VEGETABLE GARDEN: - Maximum 5 points. . . . . ___

TOTAL POINTS ________

RATING OF PHYSICAL HOME: ________"

TIME OF STUDY

The nutritional measurements were made and the dietary records were kept in 1938 and 1939, and the data were analyzed during 1939 and 1940.

NUTRITIONAL MEASUREMENTS

The tests given to the children, which have been described in detail by Mack and Smith (8), were the following:

Ratings for Nutritional Status by Physical Examination

A physical examination is one of the earliest methods of determining the nutritional status of an individual when given by a skilled pediatrician. This rating presents general evidence of the nutritional well-being of a person as judged by the condition of the skin, pallor, posture, musculature, skeletal firmness, and evidence of the presence or absence of fatigue. The method is highly subjective, however, and is believed to be more valuable when used in connection with more objective tests. In this examination, the maximum possible score is 100 points.

Measurements of Body Build

Body build measurements have been included in almost all reported studies on nutritional status. In this study, the Pryor scale involving height, iliac width, and weight standards for children of the two sexes was used, to find how closely the weights of the children compared with the respective accepted standard weights of children of the same age, sex, height, and iliac width.

Determination of Skeletal Status

Roentgenograms offer a means of determining the skeletal maturity and skeletal mineralization in children. In judging maturity the roentgenograms of hand and knee were compared with standards developed by the late T. Wingate Todd of Western Reserve University. By this method, chronological age and skeletal maturation age were compared with each other, and the difference was recorded.

Mineral density indices were obtained by the photoelectric microphotometric method in use in this laboratory, and a mineral index was calculated for each subject in the study.

Dental Status

The incidence and extent of dental caries were determined by a clinical examination made for each child by a Doctor of Dental Surgery. The results of this examination, together with complete mouth roentgenograms, made it possible to assign a dental rating score to each child. The score ranged from one to 10, with one the lowest and 10 the highest possible score.

Calculation of Slump

Two indices were calculated as slump values; the former, called standing slump, is the percentage loss in height when changing from a horizontal to a standing position, and the latter, called sitting slump, is the percentage loss in changing from a stem end to a sitting height position.

Measurements of Plantar Contact

Some investigators believe that there is a relationship between the plantar contact of a human being and nutritional status, although this relationship has not yet been definitely established. In this study, the ratio of the area of plantar contact while standing to that while sitting, as well as the average percentage of the sole of the foot touching while the subject was sitting were calculated as two separate indices.

Hemoglobin Status

The standard Newcomer Method was used to determine the amount of hemoglobin in the blood in terms of grams per hundred c.c. of blood. By this method hematin is measured against a color plate.

Biophotometer

The Biophotometer was used in the examination of each of the subjects. This test was based on the established fact that retarded dark adaptation is associated with vitamin A deficiency. The subjects were tested by the method described by Jeans and his associates (4) and by Mack and Smith (8). Calculations of data were made for each subject for each of the five indices designated by Mack and Smith as the bright light, dark regeneration, total integration, bleaching integration, and darkness integration index.

Capillary Wall Strength

Capillary wall strength was measured by the method of Dalldorf (1), as modified by Logan (5). This test is believed to be associated with

general nutritional status, although it is not a specific test for vitamin C as was originally believed. In the Pennsylvania child nutrition studies of which this is a part, blood ascorbic acid tests have recently been introduced. The method for making these tests on micro samples of blood in mass studies, as recommended by McCormick (6) was not yet developed to the point of use with large numbers of subjects until near the close of this study.

Method of Assigning Classes of Response to Nutritional Tests

For grouping the responses of the various children to the nutritional tests, the following arbitrary classifications were used:

Nutritional Status by Physical Examination

Class 1	100 - 85 points
Class 2	84 - 70 points
Class 3	69 - 55 points
Class 4	54 - 40 points
Class 5	39 and below

Weight Status by Pryor Standards

Class 1	Standard ± 10
Class 2a	11 - 15% underweight
Class 2b	11 - 15% overweight
Class 3a	16 - 20% underweight
Class 3b	16 - 20% overweight
Class 4a	21 - 25% underweight
Class 4b	21 - 25% overweight
Class 5a	26% and more underweight
Class 5b	26% and more overweight

Skeletal Status (Skeletal Maturity as Measured by the Todd Standards)*

Class 1	Same as chronological age and above, or 6 months retarded
Class 2	6.1 - 9 months retarded
Class 3	9.1 - 12 months retarded
Class 4	12.1 - 18 Months retarded
Class 5	Retarded 18.1 months and over

Dental Rating

Class 1	9 to 10 points
Class 2	7 to 8 points
Class 3	5 to 6 points
Class 4	3 to 4 points
Class 5	Below 3 points

*Skeletal mineralization classes are those of this laboratory, as yet unpublished.

Slump Standing

Percentage Slump in Standing or Sitting:

$$\frac{\text{Horizontal Height} - \text{Standing Height}}{\text{Horizontal Height}} \times 100 = \text{Slump (Standing)}$$

$$\frac{\text{Stem End} - \text{Sitting Height}}{\text{Stem End}} \times 100 = \text{Slump (Sitting)}$$

Class 1	0 to 1.99
Class 2	2 to 3.99
Class 3	4 to 5.99
Class 4	6 to 7.99
Class 5	8 to 10

Plantar Contact

a. Plantar Contact Standing/Sitting Ratio:

Class 1	1.09 and under
Class 2	1.10 to 1.14
Class 3	1.15 to 1.19
Class 4	1.20 to 1.24
Class 5	1.25 and over

b. Plantar Contact Average Percentage of Sitting Feet Touching:

Class 1	0 to 69.99
Class 2	70 to 77.99
Class 3	78 to 85.99
Class 4	86 to 92.99
Class 5	93 to 100

Hemoglobin

Class 1	13.0 and above g./100 c.c. blood
Class 2	12.99 to 11.5
Class 3	11.49 to 10.0
Class 4	9.99 to 7.5
Class 5	7.49 and below

Biophotometer (Bright Light Factor)[5]

Class 1	0.00 to 0.30 millifoot candles
Class 2	0.31 to 0.60 millifoot candles
Class 3	0.61 to 1.09 millifoot candles
Class 4	1.10 to 3.59 millifoot candles
Class 5	3.60 and above

Biophotometer (Total Integration Factor)[6]

Class 1	Under 1
Class 2	From 1.00 to 2.50

[5]*Millifoot candles required to reach end point during test immediately following bleaching.*
[6]*Area under entire biophotometer curve made in manner described by Hack and Smith, (8).*

Class 3	From 2.51 to 3.00
Class 4	From 3.01 to 5.00
Class 5	Over 5.00

Capillary Wall Strength

Class 1	No break at 55 or 60 cm. 1+ break at 55 or 60 cm.
Class 2	2+ or 3+ break at 50, 55, or 60 cm.
Class 3	4+ break at 50, 55, or 60 cm.
Class 4	3+ or 4+ break at 40 or 45 cm.
Class 5	4+ break at 30 or 45 cm.

Method of Obtaining and Calculating Dietaries

At least two visits were paid to the home of each child in the one-week period during which dietary records were being kept for the child. Adults in the family were instructed in the recording of sizes of portions of food consumed by the child, and the child was instructed concerning the importance of reporting all food eaten between meals. Any food eaten in the morning was added to breakfast in calculating the dietaries, and anything eaten in the afternoon or evening was added to the evening meal.

The average intakes of energy, protein, calcium, phosphorus, iron, vitamin A (International Units), vitamin B_1 (International Units), vitamin C (Milligrams), and riboflavin (Milligrams), were calculated from recent food value tables as found in the following references:

The Chemistry of Food and Nutrition, Henry C. Sherman, Fifth Edition, 1937, The Macmillan Company.

A Laboratory Handbook for Dietetics, Mary Swartz Rose, Fourth Edition, 1937, The Macmillan Company.

The Newer Knowledge of Nutrition, Elmer V. McCollum, Elsa Orent Keiles and Harry G. Day, Fifth Edition, 1939, The Macmillan Company.

The Nutritive Value of Fruits, Vegetables and Nuts, R. A. McCance, E. M. Widdowson and L. R. B. Shackleton, Special Report Series No. 213, 1936, Medical Research Council, London.

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The Vitamin B_1 (thiamin) Assay Value of Foods, Lela E. Booher and Eva R. Hartzler, 1939, Technical Bulletin 707, United States Department of Agriculture (Now in Press).

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Vitamin B_1 and Its Use in Medicine, Robert R. Williams and Tom D. Spies, 1938, The Macmillan Company.

Method of Assigning Unit Equivalent Values to Children on Basis of Various Nutrients

Unit equivalent values were assigned to all children by referring to the Bureau of Home Economics Standards as described by Stiebeling and Phipard (10). The nutrients - energy, protein, calcium, phosphorus, iron, vitamin A, vitamin B_1, vitamin C, and riboflavin of various individuals were related to those required by a 70-kilogram man of average size and moderate activity. By this method it is possible to obtain the approximate requirement of the individual in relation to that of a unit man, and thus resolve a heterogeneous group of people to a somewhat comparable basis. Table 1, taken from the Bureau of Home Economics values, shows the unit values used for the age groups of children in the table.

TABLE 1

NUTRIENT REQUIREMENT UNITS ASSIGNED TO INDIVIDUAL CHILDREN ON THE BASIS OF SEX AND AGE

Sex	Age	Energy Factor	Protein Factor	Calcium Factor	Phosphorus Factor	Iron Factor	Vitamin Factors			
							A	B_1	C	Ribo-flavin
Male	4- 6	0.50	0.80	1.5	0.8	0.5	0.75	0.40	0.70	0.75
Male	7- 8	0.70	1.00	1.5	0.8	0.7	0.90	0.70	0.70	0.90
Male	9-10	0.80	1.10	1.5	0.9	0.8	0.90	0.80	0.80	0.90
Male	11-12	0.83	1.10	1.5	0.9	0.9	1.00	0.83	0.90	1.00
Male	13-15	1.00	1.10	1.5	1.0	1.0	1.00	1.00	1.00	1.00
Male	16-19	1.20	1.10	1.5	1.0	1.0	1.00	1.20	1.20	1.00
Female	4- 7	0.50	0.80	1.5	0.8	0.5	0.75	0.50	0.70	0.75
Female	8-10	0.70	1.00	1.5	0.8	0.7	0.90	0.70	0.70	0.90
Female	11-13	0.80	1.10	1.5	0.9	0.8	0.90	0.80	0.80	0.90
Female	14-19	0.83	1.10	1.5	0.9	0.9	1.00	0.83	0.90	1.00

RESULTS OF THE STUDY

RESPONSES TO NUTRITION TESTS

The average responses to the various nutrition tests of the children, grouped according to income, are shown in Table 2, Parts A to C. The average responses to these tests when grouped according to family education are shown in Table 3, Parts A to C. Their average responses when they were grouped on the basis of physical home rating are shown in Table 4, Parts A to C.

Annual Family Income and Nutritional Status of Children

The average responses of the children to the various nutritional status tests are shown in Figure 1, left. The percentage distributions of the children in the different Income Groups, with respect to their responses to various of the nutritional status tests, are shown also in Figure 1, at the right.

Nutritional Rating by Physical Examination. The average score of all of the children of both sexes and of all of the socio-economic groups was 78.97 points in nutritional status by physical examination; the

TABLE 2

AVERAGE RESPONSES TO NUTRITION TESTS BASED ON VARYING INCOME LEVELS

PART A

Income Group	Sex	Number of Cases	Physical Examination Rating (Points)	Physical Examination Class	Distribution of Cases in Weight Classes According to Pryor Scale (Number of Cases): Class 1 (Correct Weight ±10%)	Under-Weight Class 2a	3a	4a	5a	Over-Weight Class 2b	3b	4b	5b	Dental Examination Rating (Points)	Dental Examination Class
A and B	Male	17	81.00	1.71	12	2	0	0	0	0	1	1	1	6.8	2.29
	Female	14	80.00	2.07	6	0	1	0	1	2	1	2	1	6.9	2.43
	All Cases	31	80.55	1.87	18	2	1	0	1	2	2	3	2	6.8	2.36
C	Male	46	78.74	1.98	32	4	0	0	1	7	0	3	0	6.8	2.28
	Female	66	79.61	1.82	29	2	0	0	1	8	11	2	2	6.2	2.69
	All Cases	101	78.14	1.89	61	6	0	0	0	15	11	5	2	6.4	2.43
D	Male	25	79.44	1.96	14	0	0	0	0	2	6	1	3	6.9	2.24
	Female	31	77.87	2.03	15	0	1	0	0	8	3	3	1	6.2	2.70
	All Cases	56	78.57	2.00	28	0	1	0	0	10	8	4	4	6.6	2.49
E	Male	14	76.83	2.07	8	1	1	1	0	1	0	0	1	6.8	2.29
	Female	23	78.70	2.04	15	0	1	0	0	0	2	1	4	6.8	2.35
	All Cases	37	78.03	2.05	24	1	2	1	0	1	2	1	5	6.9	2.33
All Children	Male	102	79.04	1.94	67	7	1	1	0	10	6	5	6	6.8	2.27
	Female	123	78.92	1.94	65	2	3	0	2	18	17	8	8	6.4	2.54
	All Cases	225	78.97	1.94	132	9	4	1	2	29	23	13	13	6.5	2.42

PART B

Income Group	Sex	Number of Cases	Skeletal Status (Class): Maturity by Todd Standards	Skeletal Status (Class): Mineral Density	Slump (Class): Standing	Slump (Class): Sitting	Plantar Contact Class: Standing/Sitting Ratio	Plantar Contact Class: Average Sitting
A and B	Male	17	1.35	2.94	1.35	3.47	2.94	1.59
	Female	14	1.71	3.07	1.07	1.79	1.57	1.64
	All Cases	31	1.51	3.00	1.22	2.71	2.32	1.61
C	Male	46	1.74	2.61	1.09	2.87	1.83	1.85
	Female	66	2.00	2.96	1.20	2.35	1.87	1.82
	All Cases	101	1.88	2.80	1.15	2.58	1.85	1.83
D	Male	25	1.50	3.12	1.04	2.32	2.25	1.80
	Female	31	2.29	3.45	1.10	1.65	1.35	2.00
	All Cases	66	1.94	3.30	1.07	1.96	1.75	1.91
E	Male	14	2.36	2.93	1.36	3.43	1.71	2.36
	Female	23	2.65	2.65	1.28	2.21	1.87	1.44
	All Cases	37	2.54	2.76	1.31	2.67	1.81	1.79
All Children	Male	102	1.70	2.83	1.18	2.91	2.19	1.86
	Female	123	2.16	3.02	1.17	2.16	1.71	1.77
	All Cases	225	1.95	2.93	1.17	2.49	1.93	1.81

PART C

Income Group	Sex	Number of Cases	Biophotometer: Bright Light Factor	Biophotometer: Class	Calculated Factors for Biophotometer Response: Dark Regeneration	Total Integration	Bleach Integration	Darkness Integration	Hemoglobin: Average (g./100 c.c. blood)	Hemoglobin: Class	Capillary Wall Strength (Class)
A and B	Male	17	0.82	2.71	0.14	1.16	0.69	0.60	13.25	1.47	1.29
	Female	14	0.36	3.00	0.16	1.50	0.86	0.63	13.19	1.29	1.14
	All Cases	31	0.46	2.84	0.15	1.31	0.77	0.66	13.22	1.38	1.22
C	Male	46	1.00	3.13	0.21	1.75	1.02	1.75	13.25	1.48	1.20
	Female	55	1.09	3.04	0.27	2.05	1.13	0.91	13.20	1.45	1.16
	All Cases	101	1.05	3.08	0.24	1.91	1.08	1.29	13.22	1.48	1.18
D	Male	25	1.24	3.40	0.27	2.24	1.27	0.97	13.53	1.24	1.16
	Female	31	1.43	3.04	0.25	2.51	1.47	1.14	13.20	1.32	1.13
	All Cases	56	1.36	3.20	0.26	2.39	1.38	1.06	13.36	1.28	1.14
E	Male	14	1.12	3.00		2.46	1.15	0.82	13.18	1.50	1.07
	Female	23	1.18	3.52		2.74	1.62	1.16	13.06	1.52	1.09
	All Cases	37	1.16	3.32		2.63	1.44	1.03	13.11	1.51	1.08
All Children	Male	102	1.01	3.11	0.22	1.80	1.04	0.77	13.30	1.42	1.09
	Female	123	1.24	3.24	0.11	2.09	1.27	0.96	13.22	1.41	1.14
	All Cases	225	1.14	3.18	0.16	1.96	1.17	0.87	13.26	1.41	1.12

TABLE 3

AVERAGE RESPONSES TO NUTRITION TESTS BASED ON VARYING EDUCATION LEVELS

PART A

Income Group	Sex	Number of Cases	Physical Examination Rating (Points)	Physical Examination Class	Distribution of Cases in Weight Classes According to Pryor Scale (Number of Cases): Class 1 (Correct Weight ±10%)	Under-Weight Class 2a	3a	4a	5a	Over-Weight Class 2b	3b	4b	5b	Dental Examination Rating (Points)	Dental Examination Class
A	Male	10	81.60	1.90	5	1	0	0	0	2	0	1		8.9	2.40
	Female	7	77.29	2.00	4	0	1	0	0	1	1	0		6.4	2.71
	All Cases	17	79.83	1.94	9	1	1	0	0	3	1	1		6.7	2.53
B	Male	14	76.64	1.64	10	1	0	0	0	0	1	1	1	7.8	1.79
	Female	10	81.70	1.80	4	0	0	0	1	1	2	2	0	7.3	2.30
	All Cases	24	78.75	1.71	14	1	0	0	1	1	3	3	1	7.6	2.00
C	Male	6	79.17	2.00	4	1	0	0	0	0	0	0	1	7.3	2.00
	Female	2	79.00	2.00	1	0	0	0	0	1	0	0	0	7.0	2.00
	All Cases	8	78.13	2.00	6	1	0	0	0	1	0	0	1	7.2	2.00
D	Male	10	75.50	1.90	10	0	0	0	0	0	0	0	0	7.0	2.20
	Female	19	80.27	1.71	8	1	0	0	0	2	3	2	3	6.4	2.53
	All Cases	29	78.62	1.78	18	1	0	0	0	2	3	2	3	6.6	2.42
E	Male	62	77.86	2.02	38	4	1	1	0	8	6	3	3	6.6	2.42
	Female	85	78.42	1.96	47	1	6	0	1	14	7	4	5	6.2	3.76
	All Cases	147	78.18	1.89	85	5	7	1	1	22	12	7	8	6.4	3.19
All Children	Male	102	79.04	1.94	67	7	1	1	0	10	6	5	5	6.8	2.27
	Female	123	78.92	1.94	65	2	3	0	2	18	17	8	8	6.4	2.54
	All Cases	225	78.97	1.94	139	9	4	1	2	28	23	13	13	6.6	2.42

PART B

Income Group	Sex	Number of Cases	Skeletal Status (Class): Maturity by Todd Standards	Skeletal Status (Class): Mineral Density	Slump (Class): Standing	Slump (Class): Sitting	Plantar Contact Class: Standing Sitting Ratio	Plantar Contact Class: Average Sitting
A	Male	10	1.00	3.00	1.20	3.20	3.10	1.60
	Female	7	2.27	4.00	1.14	3.86	3.28	1.29
	All Cases	17	1.52	3.41	1.17	3.47	3.18	1.41
B	Male	14	1.07	2.36	1.57	2.50	2.21	1.57
	Female	10	1.80	2.90	1.20	3.10	1.50	1.60
	All Cases	24	1.37	2.59	1.42	2.75	1.91	1.58
C	Male	6	2.67	3.17	1.00	3.50	3.33	2.17
	Female	2	5.00	4.00	1.00	3.50	1.50	2.50
	All Cases	8	3.25	3.38	1.00	3.50	2.87	2.25
D	Male	10	2.30	2.90	1.10	2.78	2.60	1.90
	Female	19	1.78	2.73	1.16	3.63	2.16	1.84
	All Cases	29	1.96	2.79	1.14	3.34	2.31	1.86
E	Male	62	1.76	2.87	1.13	2.85	1.79	1.95
	Female	85	2.18	3.00	1.16	3.35	2.04	1.82
	All Cases	147	1.98	2.95	1.15	3.14	1.93	1.87
All Children	Male	102	1.70	2.83	1.16	2.91	2.18	1.86
	Female	123	2.16	3.02	1.17	2.16	1.70	1.77
	All Cases	226	1.95	2.93	1.17	2.60	1.92	1.81

PART C

Income Group	Sex	Number of Cases	Biophotometer: Bright Light Factor	Biophotometer: Class	Calculated Factors for Biophotometer Response: Dark Regeneration	Total Integration	Bleach Integration	Darkness Integration	Hemoglobin: Average (g./100 c.c. blood)	Hemoglobin: Class	Capillary Wall Strength (Class)
A	Male	10	0.68	2.80	0.16	1.31	0.69	0.57	13.07	1.50	1.40
	Female	7	0.63	3.00	0.19	1.39	0.81	0.58	12.90	1.43	1.14
	All Cases	17	0.66	2.88	0.17	1.34	0.74	0.57	13.00	1.47	1.29
B	Male	14	0.65	2.86	0.17	1.14	0.66	0.49	13.11	1.57	1.07
	Female	10	1.15	3.60	0.33	2.76	1.49	1.28	13.66	1.10	1.20
	All Cases	24	0.86	3.17	0.24	1.82	1.01	0.82	13.34	1.37	1.12
C	Male	6	1.03	3.33	0.30	2.16	1.16	0.87	14.34	1.17	1.17
	Female	2	0.43	2.00	0.02	0.91	0.45	0.46	13.29	1.00	1.00
	All Cases	8	0.88	3.00	0.23	1.85	0.98	0.77	14.08	1.13	1.13
D	Male	10	1.12	3.30	0.14	2.13	1.03	0.83	13.60	1.40	1.20
	Female	19	1.24	3.06	0.60	2.51	1.43	1.08	13.01	1.47	1.17
	All Cases	29	1.20	3.14	0.44	2.38	1.29	0.94	13.21	1.45	1.18
E	Male	62	1.11	3.13	0.23	1.98	1.17	0.84	13.24	1.40	1.15
	Female	85	1.25	3.26	0.28	2.24	1.25	0.99	13.24	1.45	1.12
	All Cases	147	1.19	3.21	0.26	2.13	1.22	0.93	13.24	1.43	1.13
All Children	Male	102	1.01	3.11	0.22	1.81	1.04	0.77	13.30	1.42	1.09
	Female	123	1.24	3.24	0.11	2.09	1.27	0.96	13.22	1.41	1.14
	All Cases	225	1.14	3.18	0.16	1.96	1.17	0.87	13.26	1.41	1.12

TABLE 4

AVERAGE RESPONSES TO NUTRITION TESTS BASED ON VARYING PHYSICAL HOME LEVELS

PART A

Income Groups	Sex	Number of Cases	Physical Examination Rating (Points)	Physical Examination Class	Distribution of Cases in Weight Classes According to Pryor Scale (Number of Cases): Class 1 (Correct Weight ±10%)	Under-Weight Class 2a	3a	4a	5a	Over-Weight Class 2b	3b	4b	5b	Dental Examination Rating (Points)	Dental Examination Class
	Male	53	80.0 0	1.85	34	4	0	1	0	6	2	1	3	7.1	2.18
A	Female	50	88.68	1.70	22	2	2	0	1	8	9	0	2	6.4	2.58
	All Cases	103	84.21	1.78	56	6	2	1	1	13	11	1	5	6.8	2.37
	Male	33	78.30	2.03	21	2	0	0	0	4	4	0	0	6.2	2.45
B	Female	39	78.52	1.92	24	0	1	0	1	6	2	0	2	6.3	2.46
	All Cases	72	78.42	1.97	45	2	1	0	1	10	6	0	2	6.3	2.46
	Male	12	76.67	2.08	9	0	1	0	0	1	0	0	1	6.7	2.41
C	Female	29	79.72	2.00	18	0	0	0	0	3	5	0	2	6.4	2.56
	All Cases	41	78.83	2.02	27	0	1	0	0	4	5	0	3	6.6	2.51
	Male	4	79.76	2.00	3	1	0	0	0	0	0	0	1	7.5	2.00
O	Female	5	77.80	2.00	1	0	0	0	0	1	1	0	2	7.2	2.00
	All Cases	9	78.67	2.00	4	1	0	0	0	1	1	0	3	7.4	2.00
	Male	0	-	-	-	-	-	-	-	-	-	-	-	-	-
E	Female	0	-	-	-	-	-	-	-	-	-	-	-	-	-
	All Cases	0	-	-	-	-	-	-	-	-	-	-	-	-	-
All Children	Male	102	79.04	1.94	67	7	1	1	0	10	5	1	6	5.9	2.27
	Female	123	78.92	1.84	65	2	3	0	2	18	17	0	8	5.4	2.54
	All Cases	225	78.97	1.94	132	9	4	1	2	28	23	1	13	6.6	2.42

PART B

Income Group	Sex	Number of Cases	Skeletal Status (Class): Maturity by Todd Standards	Skeletal Status (Class): Mineral Density	Slump (Class): Standing	Slump (Class): Sitting	Planter Contact Class: Standing Sitting Ratio	Planter Contact Class: Average Sitting
	Male	53	1.40	2.85	1.25	3.09	2.32	1.18
A	Female	50	1.83	3.02	1.18	3.16	2.06	1.51
	All Cases	103	1.51	2.93	1.22	3.12	2.19	1.39
	Male	33	2.03	2.88	1.18	2.48	2.00	1.86
B	Female	39	2.34	3.33	1.16	3.36	2.10	1.92
	All Cases	72	2.20	3.12	1.17	2.95	2.05	1.90
	Male	12	1.92	3.00	1.08	2.83	2.50	1.67
C	Female	29	2.21	2.69	1.17	3.20	1.13	1.64
	All Cases	41	2.13	2.78	1.14	3.09	1.53	1.65
	Male	4	2.25	1.75	1.50	4.25	1.25	3.00
D	Female	5	3.40	2.40	1.20	3.20	1.80	1.80
	All Cases	9	2.89	2.11	1.33	3.57	1.56	2.33
	Male	0	-	-	-	-	-	-
E	Female	0	-	-	-	-	-	-
	All Cases	0	-	-	-	-	-	-
All Children	Male	102	1.70	2.83	1.15	2.91	2.19	1.86
	Female	123	2.16	3.02	1.17	2.16	1.71	1.77
	All Cases	226	1.96	2.93	1.17	2.60	1.93	1.81

PART C

Income Group	Sex	Number of Cases	Biophotometer: Bright Light Factor	Biophotometer: Class	Calculated Factors for Biophotometer Response: Dark Regeneration	Total Integration	Bleach Integration	Darkness Integration	Hemoglobin: Average (g./100 c.c. blood)	Hemoglobin: Class	Capillary Wall Strength (Class)
	Male	53	0.83	2.94	0.21	1.54	0.86	0.75	13.24	1.43	1.17
A	Female	50	1.19	3.01	0.24	1.77	1.06	0.81	13.38	1.34	1.80
	All Cases	103	1.00	2.97	0.22	1.66	0.95	0.78	13.28	1.39	1.48
	Male	33	1.19	3.33	0.22	2.06	1.21	1.85	13.42	1.39	1.09
B	Female	39	1.35	3.52	0.24	2.52	1.21	1.01	13.24	1.36	1.13
	All Cases	72	1.28	3.43	0.23	2.31	1.21	1.40	13.31	1.37	1.11
	Male	12	1.51	3.50	0.20	2.06	1.54	1.01	12.75	1.50	1.16
C	Female	29	1.12	3.28	0.30	2.75	1.29	1.19	13.02	1.59	1.14
	All Cases	41	1.23	3.34	0.27	2.55	1.36	1.14	12.94	1.66	1.15
	Male	4	0.48	1.75	0.02	0.95	0.50	0.48	13.26	1.20	0.75
D	Female	5	0.92	2.80	0.35	1.72	0.95	0.77	12.47	1.80	1.00
	All Cases	9	0.72	2.33	0.20	1.38	0.75	0.64	12.83	1.53	0.89
	Male	0	-	-	-	-	-	-	-	-	-
E	Female	0	-	-	-	-	-	-	-	-	-
	All Cases	0	-	-	-	-	-	-	-	-	-
All Children	Male	102	1.01	3.11	0.22	1.81	1.04	0.77	13.30	1.42	1.09
	Female	123	1.24	3.24	0.11	2.01	1.27	0.96	13.22	1.41	1.14
	All Cases	226	1.14	3.18	0.16	1.92	1.17	0.87	13.29	1.41	1.12

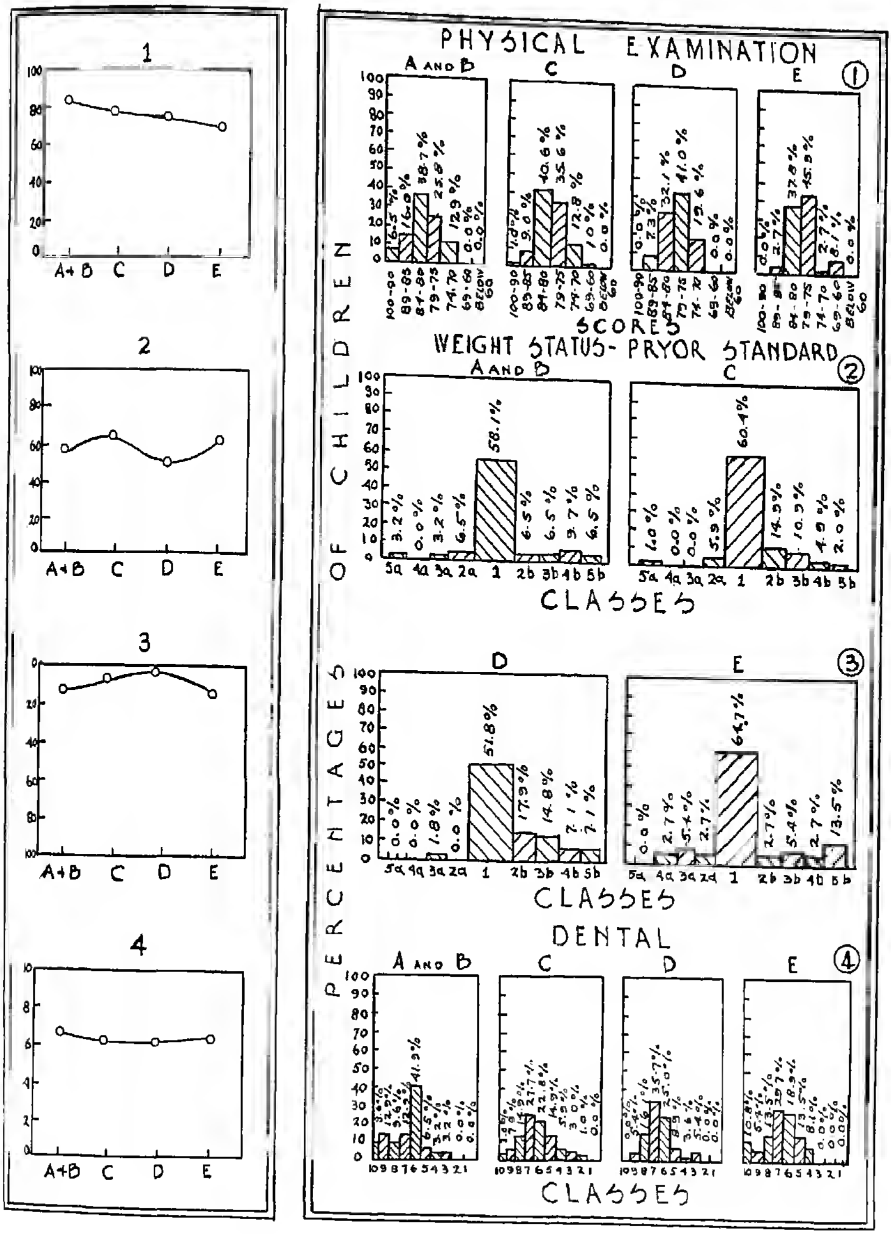


Fig. 1

For description see pages 218 and 219.

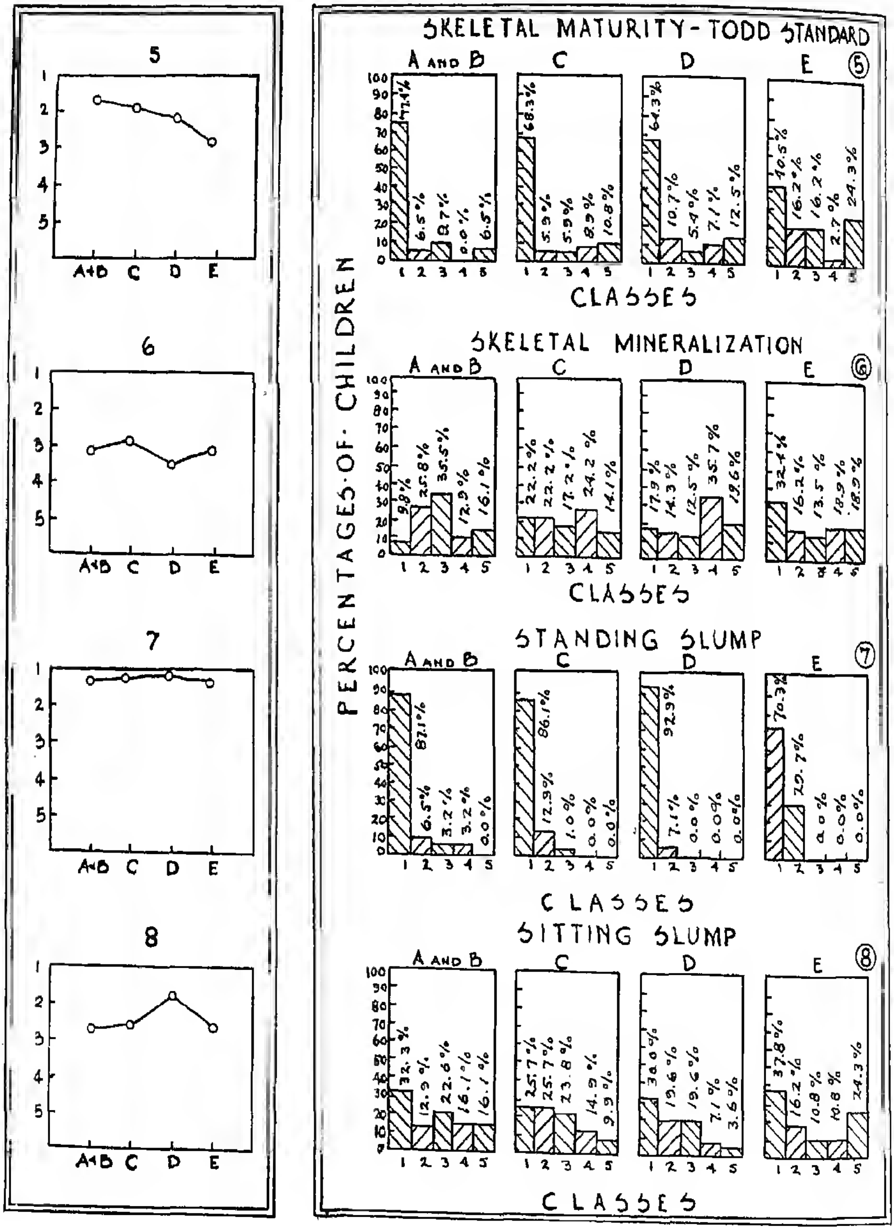


Fig. 1 (Continued)

For description see pages 218 and 219.

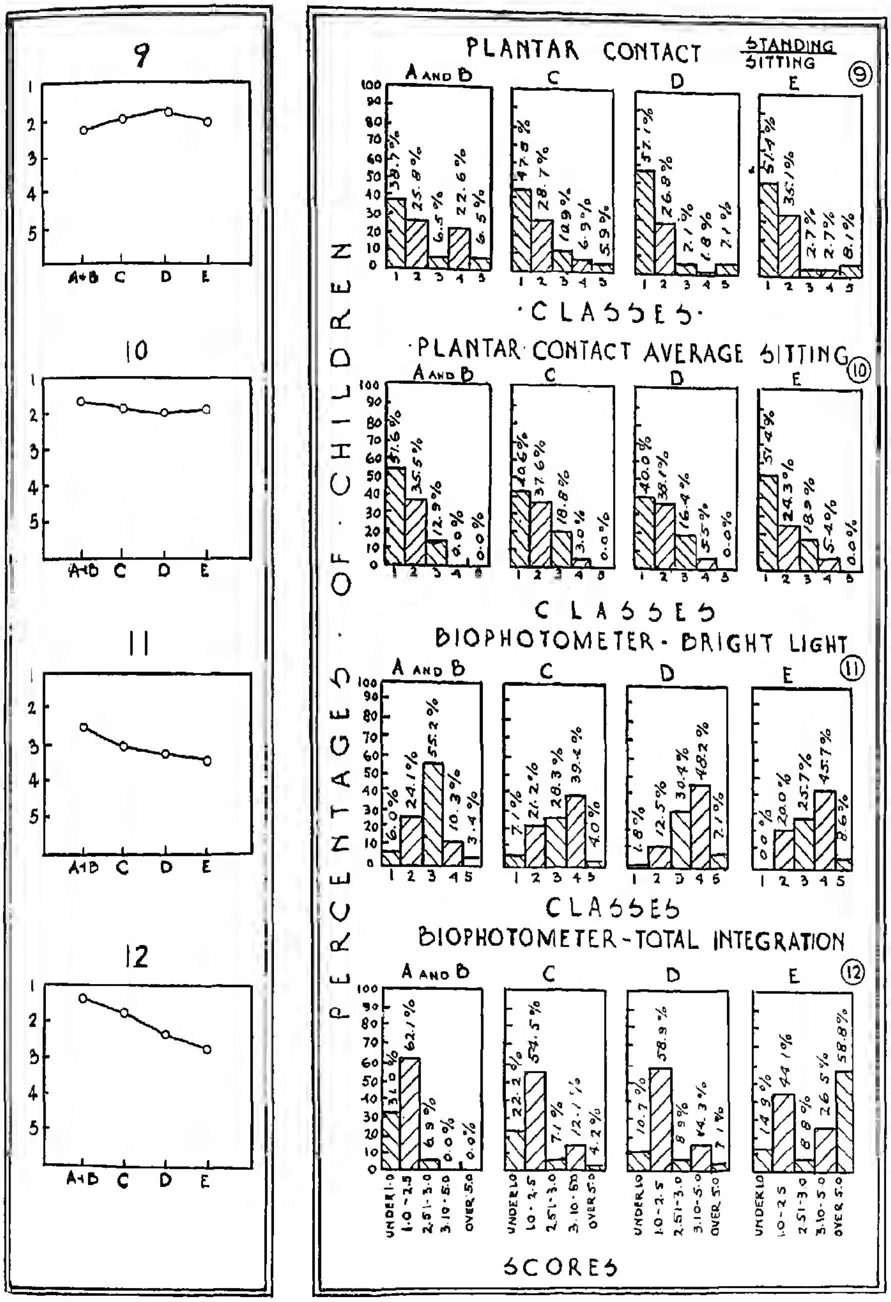
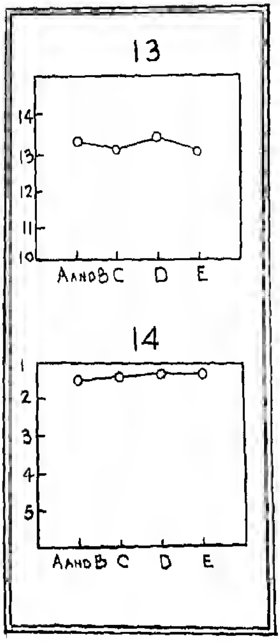


Fig. 1 (Continued)

For description see pages 218 and 219.



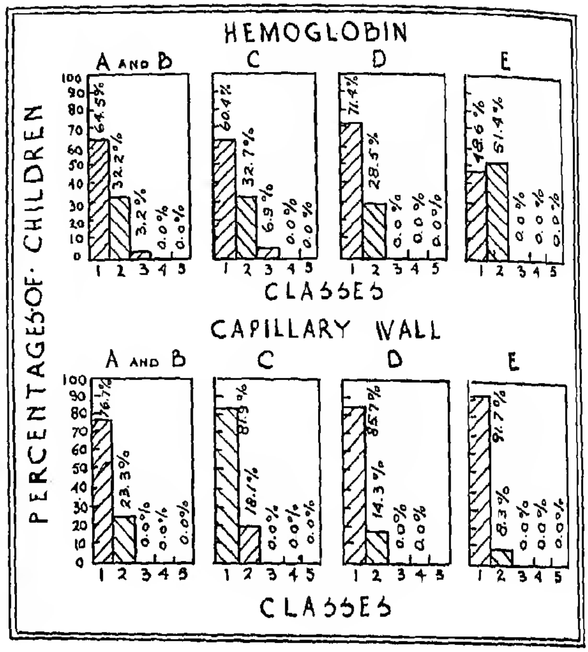


Fig. 1 (Continued)

(1) Left. Average Responses of Children of Different Income Groups to the Nutritional Rating by Physical Examination, in Terms of Scores Based on a 100-Point System.

(1) Right. Distribution of Children of Different Income Groups Among Seven Arbitrary Groupings of Physical Examination Scores.

(2) Left. Average Percentages of Children of Different Income Groups Found to be of Correct Weight ± 10 Per Cent for Their Sex, Age, Height, and Iliac Width, According to the Pryor Standards.

(3) Left. Average Percentage of Children who Were Under-Weight According to the Pryor Standards, Grouped By Income.

(2) and (3) Right. Distribution of Children of Different Income Groups Among the Various Weight Classes, with Class 1 Representing Children of Correct Weight ± 10 Per Cent, and with the (a) Groups Denoting Various Degrees of Under-Weight and the (b) of Over-Weight.

(4) Left. Average Dental Scores of Children of Different Income Groups, Based on a Rating Scheme for Dental Caries in which the Highest Score is 10.

(4) Right. Distribution of Children of Different Income Groups According to Dental Score.

(5) Left. Average Skeletal Maturity Classes of Children of Different Income Groups, with Class 1 Denoting the Highest Range of Response for This and All Tests for Which Classes are Reported.

(5) Right. Distribution of Children of Different Income Groups According to Skeletal Maturity Classes.

(6) Left. Average Skeletal Mineral Density Classes of Children of Different Income Groups.

(6) Right. Distribution of Children of Different Income Groups According to Skeletal Mineral Density Classes.

(7) Left. Average Standing Slump Classes of Children of Different Income Groups.

(7) Right. Distribution of Children of Different Income Groups According to Standing Slump Classes.

(8) Left. Average Sitting Slump Classes of Children of Different Income Groups.

(8) Right. Distribution of Children of Different Income Groups According to Sitting Slump Classes.

(9) Left. Average Plantar Contact (Ratio of Standing to Sitting) Classifications of Children of Different Income Groups.

(9) Right. Distribution of Children of Different Income Groups According to Plantar Contact (Ratio Standing to Sitting) Classes.

(10) Left. Average Plantar Contact (Percentage of Plantar Contact while Sitting) Classifications of Children of Different Income Groups.

(10) Right. Distribution of Children of Different Income Groups According to Plantar Contact (Percentage of Plantar Contact while Sitting) Classes.

(11) Left. Average Biophotometer Bright Light Classes of Children of Different Income Groups.

(11) Right. Distribution of Children of Different Income Groups According to Biophotometer Bright Light Classes.

(12) Left. Average Biophotometer Total Integration Classes of Children of Different Income Groups.

(12) Right. Distribution of Children of Different Income Groups According to Biophotometer Total Integration Classes.

(13) Left. Average Hemoglobin Values (Grams of Hemoglobin per 100 c.c. Blood) of Children of Different Income Groups.

(13) Right. Distribution of Children of Different Income Groups According to Hemoglobin Classes.

(14) Left. Average Capillary Wall Strength Classes of Children of Different Income Groups.

(14) Right. Distribution of Children of Different Income Groups According to Capillary Wall Strength Classes.

averages of the boys and of the girls were similar. Each successively lower income group averaged slightly lower than the next higher group in the physical examination scores, as is shown in Table 2, Part A, and Figure 1, Section 1. This trend is seen further in the percentage distribution of the children, grouped according to income, with respect to this test. In the figure, it may be noted that 6.5 per cent of the children in the two highest income classes, combined, were in the highest sub-division of physical rating scores, with 16.0 per cent in the second highest sub-division. In income Class C, only 1.0 per cent of the children were in the highest sub-division, with 9.0 per cent only in the second. Income Groups D and E had no children in the highest sub-division of physical rating scores, with 7.3 and 2.7 per cent, respectively, in the second highest sub-division for these two Income Groups. When two ranges of scores in the physical examination were established, one including all of 80 points and over, and the second all below this score, 61.2 per cent of the children in Income Groups A and B, combined, were in this higher range, while 50.6 per cent of Income C children, 39.4 per cent of Income D, and 40.5 per cent of Income E children were in the better classification.

Weight Status. The average percentages of children of the different income groups found to be within 10 per cent above or below the correct weight, according to the Pryor standard, shown in Table 2, Part A, and in Figure 1, Sections 2 and 3, are seen to indicate no definite trends throughout the range of income groups considered. Likewise no trend is apparent in the percentage of children who were regarded as under-weight according to the standards used, nor with respect to the distribution of

the children of the various income groups throughout the arbitrary weight classes. It has been shown by Zayaz, Mack, Sprague, and Bauman (11) that weight status was not closely related to cash income of 428 school children in an industrial community.

Dental Score. The average dental score of all of the children according to the arbitrary rating scheme for dental caries used in the study was 6.5 points; the averages of the two sexes were very similar to each other. There were no significant differences among the average dental scores of the different income groups, although the distribution graphs showing the percentage of children in the different dental score groups reveal a slight tendency for a larger percentage of children in the higher income groups to be in the highest dental rating groups. These data are presented in Table 2, Part A, and shown graphically in Figure 1, Section 4.

Skeletal Maturity. In skeletal maturity as determined by the Todd standards, all children in the study averaged Class 1.95, with the boys showing a slightly higher average than the girls, as is shown in Table 2, Part B and Figure 1, Section 5. A definite trend was apparent toward less satisfactory scores with lower income, which was consistent throughout the income range. In the graphs showing the percentage distribution of the children of different income groups in the several classes of skeletal maturity, included in Figure 1, the same tendency is seen for children of higher incomes to be in skeletal maturity classes higher than those of the lower income groups. For example, Class 1 of skeletal maturity contained 77.4 per cent of the children of Income Groups A and B, 68.3 per cent of those of Group C, 64.3 per cent of those of Group D, and 40.5 per cent of those of Group E. At the other end of the skeletal maturity scale, Class 5 contained only 6.5 per cent of the children of Income Groups A and B, combined, 10.8 per cent of those of Group C, 12.5 per cent of those of Group D, and 24.3 per cent of those of Group E.

Skeletal Mineralization. The average mineral class for all children in the study was 2.93, with the average for the boys slightly higher than that for the girls. No consistent trend could be observed for the averages of the children in the different income groups, except that the children in Income Group C were poorer than those in the higher or lower groups, as may be seen in Table 2, Part B, and in Figure 1, Section 6. The fact that the lowest income group was higher in skeletal mineralization than the next higher income groups, while being considerably lower in skeletal maturity, may be explained on the basis of the report by Zayaz, Mack, Sprague, and Bauman (11) that skeletal mineralization is in a higher class than is skeletal maturity in children of poor nutritional status, whereas the reverse is true where nutritional status is only moderately poor.

Standing and Sitting Slump. The average class rating for all children for standing and sitting slump, regardless of income level, was 1.17 and 2.49, respectively. There appears to be no definite trend in standing or sitting slump according to income class grouping, regardless of income or sex, either for averages or for percentage distribution, as may be seen in Table 2, Part B, and in Figure 1, Sections 7 and 8. This observation is in agreement with the report by Zayaz, Mack, Sprague, and Bauman (11) that no relationship was found between family income and slump ratings.

Plantar Contact. The average of all children in the study for the plantar contact standing-sitting ratio was class 1.93, with the males averaging 2.19 and females 1.71. Results of plantar contact measurements, as carried on in this laboratory, have not yet been studied sufficiently to know whether or not there is a difference between the sexes in response to this test. No definite trends are shown in the relationship between this plantar contact factor and income, as may be seen in Table 2, Part B, and in Figure 1, Sections 9 and 10. This was further borne out by the distribution of ratings on this factor within the various income groups. This is in conformity with the findings of Zayaz, Mack, Sprague, and Bauman (11).

The average class of plantar contact calculated from the average percentage of the two feet touching a level surface while the children were in a sitting position was 1.81, with the averages of the two sexes approximately equal. These plantar contact indices showed no relationship with income, in common with the plantar contact factor previously described. The percentage distribution of children of the different income groups with respect to the various classes of sitting plantar contact values again showed no relationship between income and responses to this test.

Darkness Adaptation. The average responses of the various income groups to the darkness adaptation test tended to become less satisfactory as income decreased, as shown by each of the five factors presented in Table 2, Part C. This tendency may be seen also in Figure 1, Sections 11 and 12, where the average bright light and total integration factors are graphed for the different income groups of children; the bright light factor is the value obtained in the test immediately following exposure to the bleaching light, while the total integration factor is the area under the entire biophotometer curve made according to the method described by Mack and Smith (8).

The distribution of the children in the different income groups with respect to their level of response to the biophotometer test shows the same tendency as that indicated by the averages. Whereas 30.1 per cent of the children in the two highest income groups combined were in the two highest groups of response to the bright light test, 29.3 per cent of those in the third income group, 14.3 per cent of those in the fourth, and 20.0 per cent of those in the fifth were found in these two highest groups. In the lowest two groups of response, on the other hand, only 13.7 per cent of the highest two combined income groups was found, with 43.4 per cent of those in the third income group, 55.3 per cent of those in the fourth, and 54.3 per cent of those in the fifth income groups being found in these low groups of response to the bright light photometer test.

With respect to the total integration biophotometer factor, which is a composite index of the response to the series of successive biophotometer measurements, a relationship is evident between income and darkness adaptation as shown by this test. Not only were progressively less satisfactory average total integration factors found with decreasing income, but the percentage distributions also showed the same tendency. For example, the percentages of children in the A and B income groups combined, in the C, in the D, and in the E income groups found in the two highest biophotometer total integration classes were 93.1, 76.7, 69.6,

and 59.0 per cent, respectively. In the two lowest response groups, on the other hand, the percentages were 0.0, 16.3, 21.4, and 85.3 per cent, respectively, for the same series of income groups. A similar relationship between income and response to a photometer test has been reported by Mack and Sanders (7), and by Zayaz, Mack, Sprague, and Bauman (11).

Hemoglobin. The average hemoglobin content for all of the children was 13.26 grams of hemoglobin per 100 c.c. of blood, with no significant differences between the averages of the two sexes. The average hemoglobin contents were very similar among the children of the different income groups and were all relatively high, as may be noted in Table 2, Part C, and in Figure 1, Section 13. The percentages of the children within the various income groups found in the respective levels of hemoglobin likewise showed no noteworthy trend except that, within the lowest income group, the percentage of children in the highest hemoglobin class was somewhat lower and that in the second class was somewhat higher than in the other income groups. In this lowest income group, however, there were no children in the three lowest hemoglobin classes; and the children in this as well as in all of the income groups were comparatively high in their response to this test.

Capillary Wall Strength. The average capillary wall strength of all children in the study is shown in Table 2, Part C, to be Class 1.12. The males and females were not widely different in their average response to this test, nor was any trend shown with respect to the average responses of the various income groups. Figure 1, Part 14 shows the average responses to this test of the children by income groups, as well as the distribution of the children in the different income groups with respect to this test. It is evident that all subjects in the study were in the two highest classes with respect to this test, indicating that the children of this study were not so seriously mal-nourished as were some of the subjects in other parte of the Pennsylvania mass human nutrition studies. Since this test is not specific for vitamin C, and does not indicate pre-deficiencies of this vitamin, as was believed when it first began to be used, the satisfactory response of the children in the study to this test does not necessarily indicate that they are receiving optimum quantities of vitamin C. The blood plasma ascorbic acid test of Farmer and Abt (2) as modified by McCormick (6) was not ready for general use in the Pennsylvania mass human nutrition studies until near the close of the period of record taking on the children of this study. Tests made more recently on other children in the same communities as those from which these children were taken, however, showed a wide range of blood plasma ascorbic acid values for children of high capillary wall strength.

Family Education and Nutritional Status of the Children

The averages of response of the children to the nutrition tests, when they were grouped according to family education as rated by the arbitrary scheme used in the study, are given in Table 3, page 213. These data indicate that the responses of the children showed no consistent trends in any of the following tests: nutrition rating by physical examination, weight status, dental status, slump, plantar contact, hemoglobin, or capillary wall strength. Skeletal maturity classes as judged by the Todd standards were significantly higher in each of the two highest education

groups than in each of the three lower groups, although skeletal mineralization showed no definite tendencies. All five of the photometer factors were more satisfactory for the higher than for the lower education classes.

Since the children were chosen according to the annual cash income of the families rather than on the basis of the education of the adult family members, the distribution of subjects was more satisfactory in the former rather than in the latter socio-economic classification. Of the total 225 children chosen according to cash income, for example, 147 fell into Education Class E. This probably accounts for the fact that average responses to the nutrition tests were not so consistent among education groups as among family income groups.

Physical Home Rating and Nutritional Status of Children

When the homes of the children were graded by a visiting registered nurse according to the scheme used in this study, none of the children was found to come from homes which would be rated in the lowest physical home class - Class E.

The average responses of the children when they were grouped according to their physical home ratings as given in Table 4, page 214, show the same general trends among the different groups as were evident among the groups classified on the basis of family income. No definite tendencies were seen in the relation of physical home group averages and weight status, dental status, slump, plantar contact, hemoglobin, or capillary wall strength. Nutrition rating by physical examination was abruptly lower for the successive groups below Physical Home Rating Class A. Average skeletal maturity classes became consistently less satisfactory with each succeeding lower physical home rating class, while skeletal mineralization class showed no definite trends. The photometer factors became less satisfactory, in general, as the physical home rating became lower, with the exception of Class D in which there were but nine cases.

DIETARY INTAKE

The average intakes of energy, protein, calcium, phosphorus, iron, vitamins A, B_1, C, and riboflavin by the children grouped according to family income are found in Table 5, pages 224 and 225. The average intakes of these nutrients by the children grouped according to family education are given in Table 6, pages 226 and 227; the results, when grouped according to physical home rating are given in Table 7, pages 228 and 229. In these tables, the average intakes of the children as a whole, and of the two sexes separately are presented for breakfast, lunch, dinner, all meals, and for breakfast and dinner.

The average intakes of the various nutrients specified are shown for breakfast, for lunch, for dinner, and for all meals in Figure 2, page 230, for the children of both sexes combined, grouped separately on the basis of family income, of family education, and of physical home rating. Figure 3 gives the percentages of children grouped as to family income distributed according to their intake of the various nutrients.

TABLE 5

AVERAGE INTAKE OF DIFFERENT NUTRIENTS ACCORDING TO VARYING INCOME LEVELS*

Income Class	Sex	Energy (Calories)					Protein (Grams)				
		Breakfast	Lunch	Dinner	Total	Breakfast and Dinner	Breakfast	Lunch	Dinner	Total	Breakfast and Dinner
A & B	Male	627	1043	943	2613	1570	12.8	23.5	25.9	62.2	38.7
	Female	609	1030	1146	2785	1755	12.1	26.4	29.7	68.2	41.8
	All Cases	619	1037	1035	2691	1654	12.5	24.8	27.6	64.9	40.1
C	Male	505	769	875	2149	1380	10.2	21.0	25.1	56.3	36.3
	Female	626	829	913	2368	1539	11.0	21.4	23.2	55.6	34.2
	All Cases	571	801	896	2268	1467	10.6	21.2	24.1	56.9	34.7
D	Male	430	763	793	1986	1223	8.7	20.8	22.8	62.3	31.5
	Female	559	780	873	2212	1432	12.3	20.2	24.3	56.8	36.6
	All Cases	602	772	837	2111	1339	10.7	20.4	23.7	54.8	34.4
E	Male	578	747	879	2204	1457	10.1	20.1	24.4	54.6	34.5
	Female	467	704	772	1943	1239	9.4	17.1	22.2	48.7	31.6
	All Cases	509	721	812	2042	1321	9.6	18.2	23.0	50.8	32.6
All Children	Male	517	810	861	2188	1378	10.3	21.2	24.6	56.1	34.9
	Female	577	810	909	2296	1486	11.1	20.9	24.0	56.0	35.1
	All Cases	550	810	887	2247	1437	10.7	21.0	24.3	66.1	35.0

Income Class	Sex	Calcium (Grams)					Phosphorus (Grams)				
		Breakfast	Lunch	Dinner	Total	Breakfast and Dinner	Breakfast	Lunch	Dinner	Total	Breakfast and Dinner
A & B	Male	0.19	0.23	0.20	0.62	0.39	0.46	0.52	0.62	1.60	0.98
	Female	0.21	0.24	0.23	0.68	0.44	0.38	0.62	0.65	1.65	1.03
	All Cases	0.20	0.24	0.21	0.65	0.41	0.43	0.57	0.58	1.68	1.01
C	Male	0.15	0.18	0.17	0.50	0.32	0.28	0.42	0.61	1.21	0.79
	Female	0.14	0.17	0.17	0.48	0.31	0.29	0.47	0.60	1.26	0.79
	All Cases	0.15	0.17	0.17	0.49	0.32	0.28	0.45	0.61	1.24	0.79
D	Male	0.12	0.16	0.13	0.41	0.25	0.22	0.44	0.46	1.12	0.68
	Female	0.16	0.16	0.14	0.46	0.30	0.37	0.43	0.60	1.30	0.87
	All Cases	0.14	0.16	0.14	0.44	0.28	0.30	0.43	0.48	1.21	0.78
E	Male	0.12	0.15	0.14	0.41	0.26	0.23	0.39	0.46	1.08	0.69
	Female	0.10	0.12	0.10	0.32	0.20	0.22	0.36	0.35	0.93	0.58
	All Cases	0.11	0.13	0.12	0.36	0.23	0.22	0.37	0.40	0.99	0.62
All Children	Male	0.15	0.18	0.16	0.49	0.31	0.29	0.44	0.60	1.23	0.79
	Female	0.15	0.16	0.16	0.47	0.31	0.33	0.46	0.49	1.27	0.82
	All Cases	0.15	0.17	0.16	0.48	0.31	0.31	0.45	0.50	1.25	0.81

Income Class	Sex	Iron (Grams)					Vitamin A (International Units)				
		Breakfast	Lunch	Dinner	Total	Breakfast and Dinner	Breakfast	Lunch	Dinner	Total	Breakfast and Dinner
A & B	Male	0.0026	0.0050	0.0063	0.0139	0.0089	2237	3900	4124	10261	6361
	Female	0.0024	0.0057	0.0077	0.0158	0.0101	1217	3081	5725	10023	6942
	All Cases	0.0026	0.0053	0.0069	0.0147	0.0094	1776	3530	4847	10153	6623
C	Male	0.0021	0.0039	0.0064	0.0124	0.0085	1305	2235	3136	6676	4441
	Female	0.0021	0.0045	0.0063	0.0129	0.0084	1218	2589	3290	7097	4508
	All Cases	0.0021	0.0042	0.0063	0.0126	0.0084	1258	2428	3220	6906	4478
D	Male	0.0016	0.0044	0.0057	0.0117	0.0073	949	1967	2646	5562	3595
	Female	0.0024	0.0046	0.0064	0.0134	0.0088	1204	1980	2475	5659	3679
	All Cases	0.0020	0.0046	0.0061	0.0126	0.0081	1090	1974	2551	5615	3641
E	Male	0.0018	0.0039	0.0056	0.0112	0.0073	1154	2088	2769	6011	3923
	Female	0.0015	0.0043	0.0049	0.0107	0.0064	1136	2108	1958	5202	3094
	All Cases	0.0017	0.0041	0.0051	0.0109	0.0068	1143	2101	2265	5509	3408
All Children	Male	0.0021	0.0042	0.0061	0.0124	0.0082	1392	2374	3081	6847	4473
	Female	0.0021	0.0046	0.0062	0.0129	0.0083	1199	2397	3117	6713	4316
	All Cases	0.0021	0.0044	0.0062	0.0127	0.0083	1286	2387	3100	6773	4387

*The intake values of the various nutrient factors have been calculated to a unit person basis

TABLE 5 (Continued)

Income Class	Sex	Vitamin B_1 (International Units) Breakfast	Lunch	Dinner	Total	Breakfast and Dinner	Vitamin C (Milligrams) Breakfast	Lunch	Dinner	Total	Breakfast and Dinner
A & B	Male	94.2	161.2	190.3	445.7	284.6	42.2	37.9	50.8	130.9	93.0
	Female	103.5	228.2	243.7	576.4	347.2	55.1	39.2	63.2	157.5	118.3
	All Cases	98.4	191.5	214.4	504.3	312.8	48.0	38.6	56.4	142.9	104.4
C	Male	78.7	150.9	205.7	435.3	284.4	23.3	29.8	48.3	101.4	71.6
	Female	88.5	161.3	191.0	440.8	279.6	23.9	33.0	50.2	107.1	74.1
	All Cases	84.0	166.6	197.7	438.2	281.7	23.6	31.5	49.3	104.4	72.8
D	Male	63.1	156.5	200.2	409.8	263.3	23.3	26.1	41.3	90.7	64.6
	Female	102.7	142.2	249.0	493.9	351.7	16.9	28.3	54.2	98.4	71.1
	All Cases	80.6	148.6	227.2	456.3	307.7	19.7	27.3	48.4	95.4	68.1
E	Male	61.4	124.6	156.1	342.1	217.5	10.2	31.8	38.8	80.8	49.0
	Female	53.3	130.3	183.4	367.0	236.7	7.0	38.9	48.4	94.3	55.4
	All Cases	56.4	128.1	173.1	357.6	229.5	8.2	35.2	44.8	88.2	53.0
All Children	Male	72.6	150.3	194.3	417.2	266.9	24.6	30.5	43.8	98.9	68.4
	Female	87.2	158.3	210.2	455.7	297.4	22.5	33.6	52.3	108.4	74.8
	All Cases	80.6	154.7	203.0	438.3	283.6	23.5	32.2	48.5	104.2	72.0

Income Class	Sex	Riboflavin (Milligrams) Breakfast	Lunch	Dinner	Total	Breakfast and Dinner
A & B	Male	0.46	0.33	0.39	1.17	0.84
	Female	0.46	0.49	0.50	1.45	0.96
	All Cases	0.46	0.40	0.44	1.30	0.90
C	Male	0.33	0.32	0.36	1.01	0.69
	Female	0.31	0.30	0.30	0.91	0.61
	All Cases	0.32	0.31	0.33	0.96	0.65
D	Male	0.28	0.36	0.21	0.85	0.49
	Female	0.31	0.28	0.21	0.80	0.62
	All Cases	0.30	0.31	0.21	0.82	0.61
E	Male	0.20	0.22	0.33	0.75	0.53
	Female	0.22	0.20	0.13	0.55	0.35
	All Cases	0.21	0.21	0.20	0.52	0.41
All Children	Male	0.32	0.32	0.33	0.97	0.65
	Female	0.31	0.30	0.27	0.88	0.68
	All Cases	0.32	0.31	0.29	0.92	0.61

In arriving at the averages used in the tables and figure under consideration, food eaten between meals in the morning was added to the breakfast intake; that consumed during the afternoon and evening was added to the dinner intako.

An interesting point to consider in examining Figure 3 is the relative average amounts of the various nutrients consumed at the three meals of the day. No notable difference in the consumption at the three meals, for the entire series of groups of children divided according to each of the three socio-economic factors, was seen for the following nutrients: calcium and riboflavin. Breakfast was lower than the other two meals, which were practically the same, in consumption of the following: energy, and phosphorus. Breakfast, lunch, and dinner became progressively greater in average intake, in the main, for the following: protein, iron, vitamin A, vitamin B_1, and vitamin C.

Socio-Economic Status and Dietary Intake of Children

The three socio-economic factors of family cash income, family education, and physical home rating have been found by Sanders (9) in a study

TABLE 6

AVERAGE INTAKE OF DIFFERENT NUTRIENTS ACCORDING TO VARYING EDUCATION LEVELS*

Education Class	Sex	Energy (Calories) Breakfast	Lunch	Dinner	Total	Breakfast and Dinner	Protein (Grams) Breakfast	Lunch	Dinner	Total	Breakfast and Dinner
A	Male	713	1141	1010	2864	1723	14.1	23.8	27.6	65.5	41.7
	Female	727	1105	1231	3063	1958	14.7	27.6	30.7	73.0	45.4
	All Cases	718	1127	1096	2941	1814	14.3	25.3	28.8	68.4	43.1
B	Male	604	960	964	2528	1568	12.5	23.7	25.8	62.0	38.3
	Female	488	879	1008	2376	1497	11.2	21.6	27.3	60.1	38.5
	All Cases	656	926	982	2464	1538	12.0	22.8	26.4	61.2	38.4
C	Male	379	802	915	2096	1294	8.9	21.8	26.2	56.8	35.1
	Female	710	1222	1155	3117	1895	14.2	23.9	27.6	66.7	41.8
	All Cases	498	942	995	2436	1494	10.7	22.6	26.7	59.9	37.4
D	Male	601	778	868	2147	1369	10.3	18.0	26.2	53.5	35.6
	Female	870	779	912	2561	1782	11.3	20.4	24.4	56.1	35.7
	All Cases	738	778	897	2414	1635	10.9	18.5	24.7	55.1	35.5
E	Male	478	722	804	2004	1282	8.2	20.7	23.5	63.4	32.7
	Female	608	769	861	2138	1368	10.7	20.2	22.8	63.8	33.6
	All Cases	496	760	837	2082	1332	10.1	20.4	23.2	53.7	33.3
All Children	Male	517	810	861	2188	1378	10.3	21.2	24.6	56.1	34.9
	Female	577	810	908	2296	1486	11.1	20.9	24.0	56.0	35.1
	All Cases	550	810	887	2247	1437	10.7	21.0	24.3	56.1	35.0

Education Class	Sex	Calcium (Grams) Breakfast	Lunch	Dinner	Total	Breakfast and Dinner	Phosphorus (Grams) Breakfast	Lunch	Dinner	Total	Breakfast and Dinner
A	Male	0.21	0.26	0.20	0.66	0.41	0.46	0.51	0.63	1.60	0.99
	Female	0.26	0.26	0.27	0.79	0.63	0.45	0.70	0.71	1.86	1.16
	All Cases	0.23	0.25	0.23	0.71	0.46	0.46	0.58	0.60	1.64	1.06
B	Male	0.20	0.22	0.18	0.60	0.38	0.37	0.55	0.67	1.49	0.94
	Female	0.17	0.20	0.19	0.68	0.36	0.32	0.48	0.58	1.38	0.90
	All Cases	0.19	0.21	0.18	0.68	0.37	0.35	0.52	0.57	1.44	0.92
C	Male	0.16	0.17	0.15	0.51	0.34	0.25	0.45	0.52	1.23	0.77
	Female	0.15	0.20	0.16	0.52	0.32	0.33	0.52	0.66	1.41	0.89
	All Cases	0.16	0.18	0.17	0.61	0.33	0.28	0.48	0.53	1.28	0.81
D	Male	0.16	0.15	0.18	0.50	0.38	0.25	0.37	0.82	1.14	0.77
	Female	0.18	0.16	0.15	0.47	0.31	0.31	0.43	0.50	1.24	0.81
	All Cases	0.16	0.16	0.16	0.48	0.32	0.29	0.41	0.61	1.21	0.80
E	Male	0.12	0.16	0.15	0.43	0.27	0.25	0.41	0.47	1.13	0.72
	Female	0.13	0.16	0.15	0.43	0.28	0.32	0.43	0.46	1.21	0.78
	All Cases	0.13	0.16	0.15	0.44	0.28	0.29	0.42	0.46	1.18	0.39
All Children	Male	0.15	0.18	0.16	0.49	0.31	0.29	0.44	0.50	1.23	0.79
	Female	0.15	0.16	0.16	0.47	0.31	0.33	0.45	0.49	1.27	0.82
	All Cases	0.15	0.17	0.16	0.48	0.31	0.31	0.45	0.50	1.25	0.81

Education Class	Sex	Iron (Grams) Breakfast	Lunch	Dinner	Total	Breakfast and Dinner	Vitamin A (International Units) Breakfast	Lunch	Dinner	Total	Breakfast and Dinner
A	Male	0.0031	0.0051	0.0074	0.0156	0.0105	1875	3852	3871	9699	5847
	Female	0.0030	0.0058	0.0076	0.0164	0.0106	1508	3250	4609	9377	6117
	All Cases	0.0031	0.0054	0.0075	0.0160	0.0106	1733	3522	4219	8574	5952
B	Male	0.0025	0.0048	0.0066	0.0139	0.0091	2361	3733	4250	10344	6611
	Female	0.0022	0.0043	0.0080	0.0146	0.0102	1047	2329	5185	8561	6232
	All Cases	0.0023	0.0045	0.0072	0.0141	0.0096	1814	3148	4639	9601	6453
C	Male	0.0016	0.0052	0.0068	0.0135	0.0083	971	1946	3247	6164	4218
	Female	0.0026	0.0045	0.0070	0.0141	0.0096	1731	2385	2510	6626	4241
	All Cases	0.0019	0.0050	0.0069	0.0138	0.0088	1224	2092	3002	6318	4226
D	Male	0.0016	0.0042	0.0061	0.0119	0.0077	1327	2228	3528	7083	4855
	Female	0.0023	0.0045	0.0058	0.0126	0.0081	1416	2602	3462	7480	4878
	All Cases	0.0020	0.0044	0.0059	0.0123	0.0079	1384	2469	3485	7338	4869
E	Male	0.0020	0.0038	0.0056	0.0114	0.0076	1134	1851	2662	6557	3696
	Female	0.0020	0.0046	0.0059	0.0125	0.0079	1127	2291	2698	6117	3826
	All Cases	0.0020	0.0043	0.0058	0.0121	0.0078	1130	2111	2642	5883	3772
All Children	Male	0.0021	0.0042	0.0061	0.0124	0.0082	1392	2374	3081	6847	4473
	Female	0.0021	0.0046	0.0052	0.0129	0.0083	1199	2397	3117	6713	4316
	All Cases	0.0021	0.0044	0.0062	0.0127	0.0083	1286	2387	3100	5773	4387

*The intake values of the various nutrient factors have been calculated to a unit person basis.

TABLE 6 (Continued)

Education Class	Sex	Vitamin B_1 (Instructional Units) Breakfast	Lunch	Dinner	Total	Breakfast and Dinner	Vitamin C (Milligrams) Breakfast	Lunch	Dinner	Total	Breakfast and Dinner
A	Male	158.3	160.9	234.8	544.0	393.1	49.2	41.4	57.7	148.3	106.9
	Female	117.1	263.6	245.2	625.9	362.3	57.0	41.1	67.8	185.9	124.8
	All Cases	142.3	194.7	238.8	575.8	381.1	52.2	41.3	61.6	155.1	113.8
B	Male	95.7	203.2	203.6	502.5	299.3	39.8	31.3	47.3	118.4	87.1
	Female	85.4	174.8	236.9	497.1	322.3	41.6	25.8	59.7	127.1	101.3
	All Cases	91.4	191.3	217.5	600.2	308.9	40.5	29.0	62.6	122.0	93.0
C	Male	61.1	131.2	194.2	386.5	255.3	19.5	40.1	47.8	107.4	67.3
	Female	80.0	121.3	129.2	330.6	209.2	20.8	15.7	27.8	64.3	48.6
	All Cases	67.4	127.9	172.5	367.8	239.0	18.9	32.0	41.1	93.0	61.0
D	Male	54.6	126.8	246.8	428.1	301.3	18.8	24.4	54.4	97.6	73.2
	Female	101.4	158.9	263.8	514.1	355.2	21.6	40.4	52.9	114.0	74.5
	All Cases	84.6	147.4	251.3	483.3	335.9	20.6	34.7	53.4	108.7	74.0
E	Male	66.0	143.8	176.3	376.1	232.3	18.2	28.4	38.4	85.0	56.6
	Female	82.2	148.9	197.8	428.9	280.0	17.7	33.1	50.9	101.7	68.6
	All Cases	71.2	146.8	188.8	406.8	260.0	17.9	31.1	45.7	94.7	63.6
All Children	Male	72.6	160.3	194.3	417.2	266.9	24.6	30.6	43.8	98.9	68.4
	Female	87.2	158.3	210.2	455.7	297.4	22.5	33.6	52.3	108.4	74.8
	All Cases	80.6	154.7	203.0	438.3	283.6	23.5	32.2	48.5	104.2	72.0

Education Class	Sex	Riboflavin (Milligrams) Breakfast	Lunch	Dinner	Total	Breakfast and Dinner
A	Male	0.50	0.36	0.33	1.18	0.83
	Female	0.66	0.49	0.67	1.62	1.13
	All Cases	0.52	0.40	0.42	1.34	0.94
B	Male	0.46	0.38	0.43	1.28	0.89
	Female	0.41	0.39	0.38	1.16	0.77
	All Cases	0.44	0.39	0.40	1.23	0.84
C	Male	0.38	0.35	0.32	1.05	0.70
	Female	0.38	0.39	0.38	1.15	0.76
	All Cases	0.38	0.38	0.34	1.08	0.72
D	Male	0.33	0.28	0.41	1.02	0.74
	Female	0.36	0.31	0.27	0.93	0.62
	All Cases	0.34	0.30	0.32	0.96	0.66
E	Male	0.25	0.30	0.29	0.84	0.54
	Female	0.27	0.27	0.22	0.76	0.49
	All Cases	0.26	0.28	0.26	0.79	0.51
All Children	Male	0.32	0.32	0.33	0.97	0.65
	Female	0.31	0.30	0.27	0.88	0.58
	All Cases	0.32	0.31	0.29	0.92	0.61

of dietary habits and nutritional status of family members to be closely related to each other, and to intake of various nutrients by members of a family. Sanders found that family income and education were more closely correlated with each other than with physical home rating, and that each of these was more closely related to dietary intake than was physical home rating. In this study, all three factors were considered in order to find which ones might be useful in determining which children in a school system might require foods in addition to the diets received at home, in order to attain satisfactory nutritional status. Whereas dietary intake of the various nutrients under consideration showed the same general trends for all three nutritional factors, physical home rating appeared in this study, as in Sanders, to give the least consistent results. Where no other means of arriving at the family income or education were available, however, the latter factor could be used as a means of obtaining an estimate of the probable dietary needs of a child. It would seem that the first two factors, particularly the former, however, could be ascertained more readily than the last.

TABLE 7

AVERAGE INTAKE OF DIFFERENT NUTRIENTS ACCORDING TO VARIOUS PHYSICAL HOME LEVELS*

Physical Home Class	Sex	Energy (Calories) Breakfast	Energy Lunch	Energy Dinner	Energy Total	Energy Breakfast and Dinner	Protein (Grams) Breakfast	Protein Lunch	Protein Dinner	Protein Total	Protein Breakfast and Dinner
A	Male	557	852	923	2332	1480	10.9	21.1	26.1	58.1	37.0
	Female	716	885	1044	2645	1760	12.5	22.1	25.6	60.1	38.0
	All Cases	634	868	982	2484	1616	11.7	21.6	26.8	59.1	37.6
B	Male	436	760	811	1996	1246	9.2	22.6	24.1	56.9	33.3
	Female	487	810	876	2172	1362	10.7	20.7	22.8	54.2	33.5
	All Cases	463	783	845	2091	1308	10.0	21.6	23.4	55.0	33.4
C	Male	433	794	714	1942	1148	9.6	18.9	19.2	47.7	28.8
	Female	470	701	768	1939	1238	9.4	19.9	24.9	54.2	34.3
	All Cases	460	728	753	1941	1213	9.5	19.6	23.2	52.3	32.7
D	Male	888	867	1067	2822	1955	12.1	18.6	25.2	55.8	37.3
	Female	520	679	638	1837	1158	10.5	14.8	14.9	40.2	25.4
	All Cases	683	762	829	2274	1512	11.2	16.5	19.5	47.2	30.7
All Children	Male	617	810	861	2188	1378	10.3	21.2	24.6	56.1	34.8
	Female	577	810	909	2296	1486	11.1	20.9	24.0	56.0	35.1
	All Cases	560	810	887	2247	1437	10.7	21.0	24.3	56.1	35.0

Physical Home Class	Sex	Calcium (Grams) Breakfast	Calcium Lunch	Calcium Dinner	Calcium Total	Calcium Breakfast and Dinner	Phosphorus (Grams) Breakfast	Phosphorus Lunch	Phosphorus Dinner	Phosphorus Total	Phosphorus Breakfast and Dinner
A	Male	0.17	0.20	0.17	0.54	0.34	0.32	0.44	0.49	1.25	0.81
	Female	0.18	0.19	0.18	0.55	0.36	0.34	0.49	0.58	1.39	0.90
	All Cases	0.17	0.20	0.18	0.65	0.35	0.33	0.47	0.52	1.32	0.85
B	Male	0.13	0.17	0.16	0.46	0.29	0.26	0.44	0.48	1.16	0.72
	Female	0.13	0.16	0.16	0.45	0.29	0.31	0.46	0.48	1.25	0.79
	All Cases	0.13	0.16	0.16	0.45	0.29	0.29	0.45	0.47	1.21	0.76
C	Male	0.14	0.14	0.15	0.43	0.29	0.24	0.38	0.43	1.05	0.67
	Female	0.11	0.13	0.12	0.36	0.23	0.25	0.40	0.43	1.08	0.68
	All Cases	0.12	0.13	0.13	0.38	0.25	0.25	0.40	0.43	1.08	0.68
D	Male	0.13	0.11	0.13	0.37	0.26	0.25	0.31	0.45	1.01	0.70
	Female	0.13	0.11	0.07	0.31	0.20	0.22	0.31	0.28	0.81	0.50
	All Cases	0.13	0.11	0.10	0.34	0.23	0.25	0.31	0.35	0.91	0.60
All Children	Male	0.15	0.18	0.16	0.49	0.31	0.29	0.44	0.50	1.23	0.79
	Female	0.15	0.16	0.16	0.47	0.31	0.33	0.45	0.49	1.27	0.82
	All Cases	0.15	0.17	0.16	0.48	0.31	0.31	0.45	0.60	1.25	0.81

Physical Home Class	Sex	Iron (Grams) Breakfast	Iron Lunch	Iron Dinner	Iron Total	Iron Breakfast and Dinner	Vitamin A (International Units) Breakfast	Vitamin A Lunch	Vitamin A Dinner	Vitamin A Total	Vitamin A Breakfast and Dinner
A	Male	0.0022	0.0043	0.0066	0.0131	0.0088	1676	2915	3795	8386	5471
	Female	0.0024	0.0046	0.0068	0.0138	0.0092	1343	2646	4186	8175	5529
	All Cases	0.0023	0.0044	0.0067	0.0134	0.0090	1515	2784	3986	8284	5500
B	Male	0.0020	0.0044	0.0059	0.0123	0.0079	1128	2094	2306	5528	3434
	Female	0.0018	0.0050	0.0063	0.0132	0.0082	1114	2597	2857	8568	3871
	All Cases	0.0019	0.0047	0.0062	0.0128	0.0081	1120	2366	2605	6091	3725
C	Male	0.0014	0.0037	0.0044	0.0096	0.0058	857	1705	1696	4258	2553
	Female	0.0020	0.0044	0.0054	0.0118	0.0074	1058	1862	1904	4815	2963
	All Cases	0.0018	0.0042	0.0051	0.0111	0.0069	1000	1809	1843	4652	2843
D	Male	0.0024	0.0038	0.0063	0.0125	0.0087	1402	2130	4156	7688	5558
	Female	0.0017	0.0038	0.0040	0.0095	0.0057	1238	1516	1479	4233	2717
	All Cases	0.0020	0.0038	0.0050	0.0108	0.0070	1311	1789	2669	5769	3980
All Children	Male	0.0021	0.0042	0.0061	0.0124	0.0082	1392	2374	3081	6847	4473
	Female	0.0021	0.0046	0.0062	0.0129	0.0083	1198	2397	3117	6713	4316
	All Cases	0.0021	0.0044	0.0062	0.0127	0.0083	1286	2387	3100	6773	4387

*The intake values of the various nutrient factors have been calculated to a unit person basis.

TABLE 7 (Continued)

Physical Home Class	Sex	Vitamin B_1 (International Units) Breakfast	Lunch	Dinner	Total	Breakfast and Dinner	Vitamin C (Milligrams) Breakfast	Lunch	Dinner	Total	Breakfast and Dinner[6]
A	Male	74.8	155.3	214.9	445.0	289.7	28.7	34.0	55.2	117.9	83.9
	Female	89.0	180.0	224.2	493.2	313.2	36.0	34.4	58.2	128.6	94.2
	All Cases	81.7	167.2	219.4	468.3	301.1	32.3	34.2	56.7	123.2	89.0
B	Male	73.9	153.1	183.4	410.4	257.3	24.8	26.6	32.8	84.1	57.6
	Female	76.5	149.9	221.5	447.9	298.0	16.0	37.9	55.2	109.1	71.2
	All Cases	75.3	161.4	204.1	430.8	279.4	20.0	32.7	45.0	97.7	65.0
C	Male	65.1	138.2	157.7	361.0	222.8	11.1	23.8	39.8	74.7	50.9
	Female	106.0	136.4	168.7	411.1	274.7	9.3	26.4	37.9	73.6	47.2
	All Cases	94.0	136.9	165.5	396.4	259.6	9.8	25.7	38.4	73 .9	48.2
D	Male	56.1	99.1	137.6	291.8	192.7	3.8	34.9	48.6	87.2	52.3
	Female	44.2	147.8	208.4	400.4	252.6	14.7	34.0	54.2	102.9	68.9
	All Cases	49.0	126.1	176.9	352.0	225.9	9.8	34.4	51.7	95.9	61.5
All Children	Male	72.6	150.3	194.3	417.2	266.9	24.6	30.5	43.8	98.9	68.4
	Female	87.2	158.3	210.2	455.7	297.4	22.5	33.6	52.3	108.4	74.8
	All Cases	80.6	154.7	203.0	438.3	283.6	23.5	32.2	48.5	104.2	72.0

Physical Home Class	Sex	Riboflavin (Milligrams) Breakfast	Lunch	Dinner	Total	Breakfast and Dinner
A	Male	0.37	0.33	0.35	1.05	0.72
	Female	0.38	0.37	0.36	1.11	0.74
	All Cases	0.37	0.35	0.36	1.08	0.73
B	Male	0.28	0.38	0.29	0.95	0.57
	Female	0.28	0.29	0.26	0.83	0.54
	All Cases	0.28	0.33	0.27	0.88	0.56
C	Male	0.27	0.16	0.28	0.71	0.55
	Female	0.26	0.20	0.14	0.60	0.40
	All Cases	0.26	0.19	0.18	0.63	0.44
D	Male	0.22	0.20	0.42	0.84	0.64
	Female	0.19	0.20	0.06	0.45	0.25
	All Cases	0.20	0.20	0.22	0.62	0.42
All Children	Male	0.32	0.32	0.33	0.97	0.65
	Female	0.31	0.30	0.27	0.88	0.58
	All Cases	0.32	0.31	0.29	0.92	0.61

Energy. It is seen from Tables 5, 6, and 7, and from Figure 2 that the average energy intake of the children tended to fall slightly with descending classes of family income, family education, and physical home rating, with the results based on the last factor showing less consistent trends than those based on the other two, as has been mentioned. The average range of daily energy intake per unit person, with the children grouped according to family income, ranged from 2691 calories for those in the two highest income groups, to 2042 calories for those in the lowest group. The average of the highest income groups approached the 3000 unit person calorie requirement estimated by the Bureau of Home Economics as outlined by Stiebeling and Phipard (10), whereas that of the lowest income group was approximately 30 per cent below this standard.

The distribution of the children among five arbitrary groups of energy intake based on the range of intake of the children in the study, as shown in Figure 3, Sections 1, 2, 3, and 4, exhibits the same tendencies for the various income groups as was shown by the average intakes. For

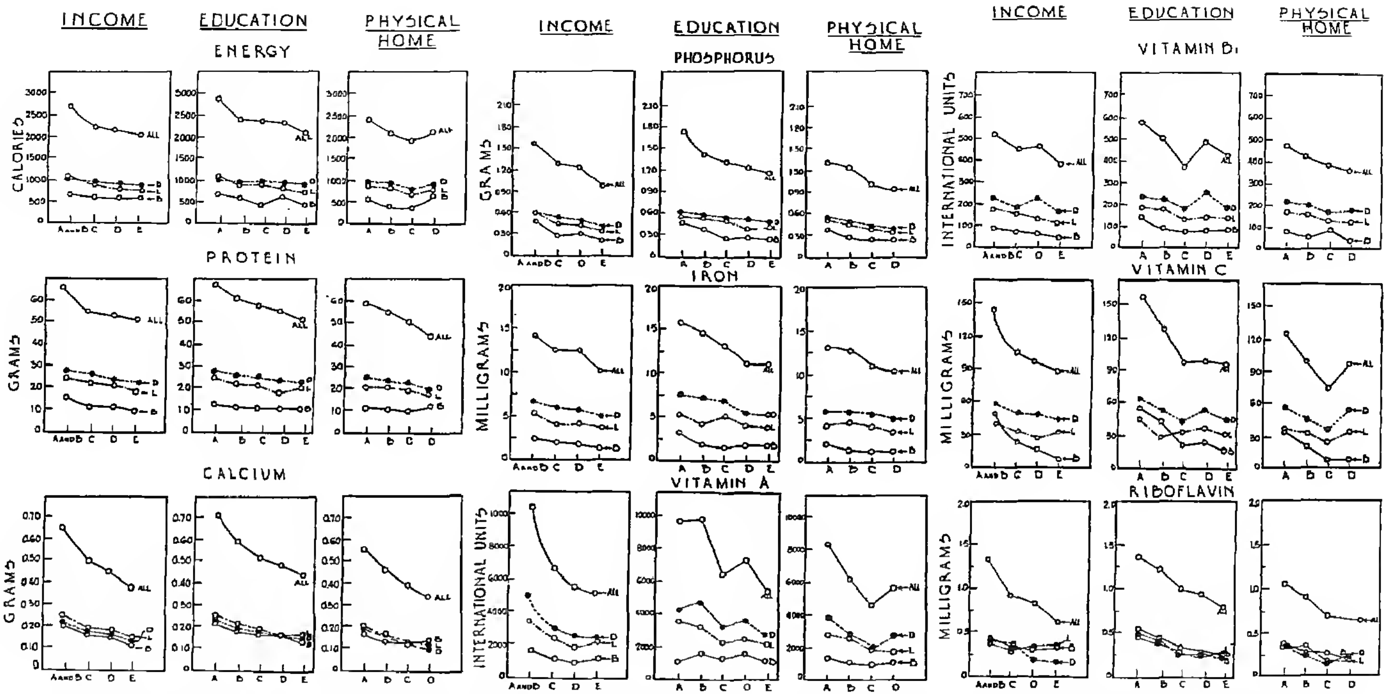


Fig. 2. Intakes of Energy, of Protein, and of Calcium by the Children Grouped as to Family Income, Family Education, and Physical Home Rating. The intakes were calculated on the Basis of Unit Person Intake for all Meals (Marked All), for Breakfast (B), for Lunch (L), and for Dinner (D).

Intakes of Phosphorus, of Iron, and of Vitamin A by the Children Grouped as to Family Income, Family Education, and Physical Home Rating. The Intakes were Calculated on the Basis of Unit Person Intake for All Meals (Marked All), for Breakfast (B), for Lunch (L), and for Dinner (D).

Intakes of Vitamin B_1, of Vitamin C, and of Riboflavin by the Children Grouped as to Family Income, Family Education, and Physical Home Rating. The Intakes were Calculated on the Basis of Unit Person Intake for All Meals (Marked All), for Breakfast (B), for Lunch (L), and for Dinner (D).

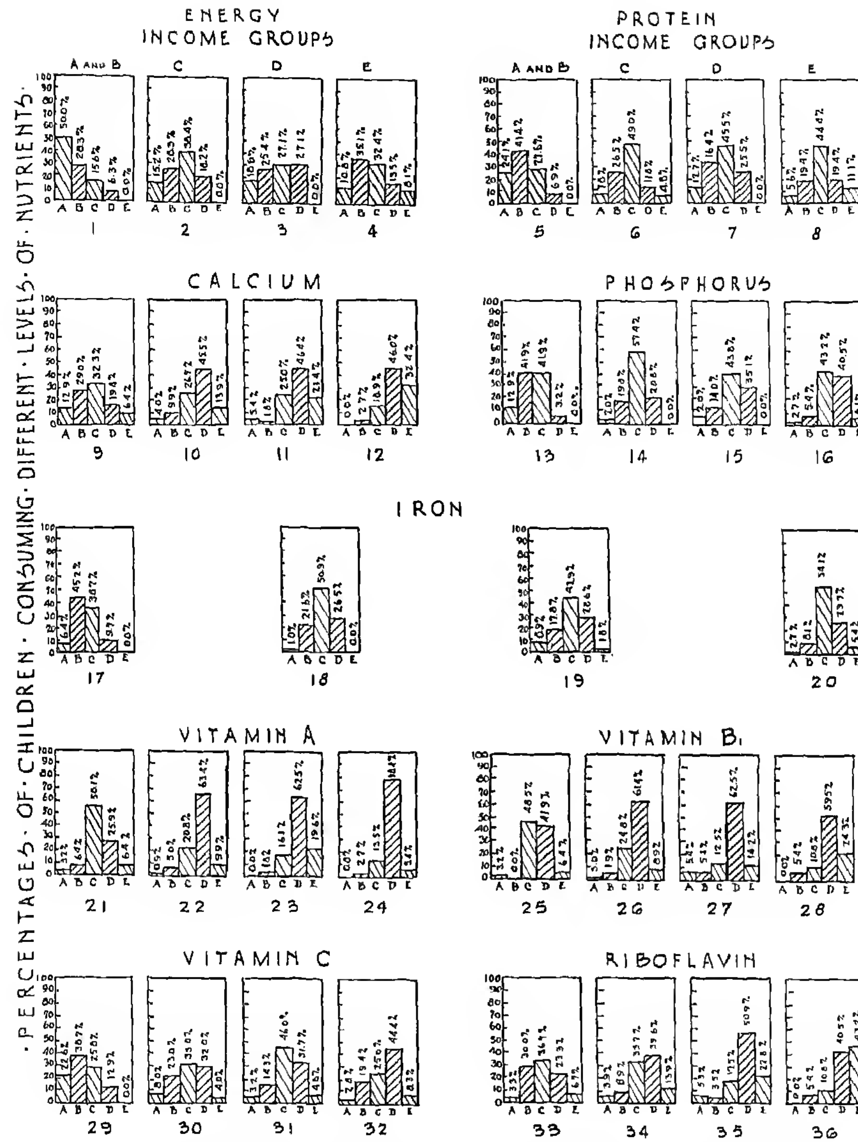


Fig. 3. Percentages of Children Grouped as to Family Income, Distributed According to Intake of Nutrients. The Intake of Energy in Calories is given in Sections 1, 2, 3, and 4; that of Protein in Grams in Sections 5, 6, 7 and 8; that of Calcium in Grams in Sections 9, 10, 11, and 12; that of Phosphorus in Grams in Sections 13, 14, 15, and 16; that of Iron in Grams in Sections 17, 18, 19, and 20; that of Vitamin A in International Units in Sections 21, 22, 23, and 24; that of Vitamin B_1 in International Units in Sections 25, 26, 27, and 28; that of Vitamin C in Milligrams in Sections 29, 30, 31, and 32; and that in Riboflavin in Sections 33, 34, 35, and 36.

Key to Energy Intake Groups: A = 2800 calories and above; B = 2799 - 2200; C = 2100 to 1600;

D = 1599 - 1000; and E = Below 1000 calories.

Key to Protein Intake Groups: A = 75 grams and above; B = 74 - 60; C = 59 - 45; D = 44 - 30; and E = Below 30 grams.

Key to Calcium Intake Groups: A = 0.80 grams and above; B = 0.88 - 0.69; C = 0.68 - 0.49; D = 0.48 - 0.29; and E = Below 0.29 grams.

Key to Phosphorus Intake Groups: A = 2.00 grams and above; B = 1.00 - 1.60; C = 1.49 - 1.00; D = 0.99 - 0.50; E = Below 0.50.

Key to Iron Intake Groups: A = 0.0200 grams and above; B = 0.0199 - 0.0150; C = 0.0149 to 0.0100; D = 0.0099 - 0.0060; and E = Below 0.0050 grams.

Key to Vitamin A Intake Groups: A = 24,000 International Units and above; B = 23,999 - 13,000; C = 12,909 - 8,000; D = 7,999 - 3,000; and E = Below 3,000 grams.

Key to Vitamin B_1 Intake Groups: A = 1,000 International Units and above; B = 909 - 750; C = 749 - 500; D = 499 - 250; and E = Below 250 International Units.

Key to Vitamin C Intake Groups: A = 120 Milligrams and above; B = 119 - 90; C = 80 - 60; D = 59 - 30; and E = Below 30 Milligrams.

Key to Riboflavin Intake Groups: A = 1.80 Milligrams and above; B = 1.79 - 1.30; C = 1.29 - 0.80; D = 0.79 - 0.30; and E = Below 0.30 Milligrams.

example, 50.0 per cent of the children of the A and B Income Groups, combined, had an energy intake of 2800 calories per unit person, daily, with 28.3 per cent of the children of these income groups consuming from 2799 to 2200 calories, 15.6 per cent from 2199 to 1600 calories, 6.3 per cent from 1599 to 1000 calories, and none falling below 1000 calories. The children in the successively lower income groups had a general tendency toward lower percentages of their numbers in the higher energy intake groups and higher percentages of their numbers in the lower energy intake groups, although only Income Group E included any children eating less than 1000 calories per unit person, daily.

Protein. The average protein intake gradually declined with lowered family income, family education, and physical home rating. The highest income group was the only one which approached the Bureau of Home Economics standard of 67 grams per unit person, daily, with the lowest income group averaging only about 75 per cent of this amount.

The distribution graphs of the children of different income groups with respect to their protein intake, as shown in Figure 3, Sections 5, 6, 7, and 8, shows a decreasing percentage of children in the higher protein intake groups and an increasing percentage in the lower groups as incomes became lower. Thus, in the highest income grouping (Incomes A and B, combined) 24.1 per cent of the children consumed 75 grams or more of protein per unit person, daily, and 41.4 per cent consumed from 74 to 60 grams, while 34.3 per cent of the children in Income Group C, 29.1 per cent of those in Income Group D, and 25.0 per cent of those in Group E were included within these two highest protein intake groups. In Income Groups A and B, combined, on the other hand, 27.6 per cent of the children were included in the third group with respect to protein intake (59 to 45 grams per unit person, daily), with 6.9 per cent consuming from 44 to 30 grams, and none receiving less than 30 grams per unit person, daily. A general tendency was shown for the percentages of the children to be greater in the three lower groups of protein intake as income was less, with 11.1 per cent of the children in Income Group E consuming less than 30 grams of protein daily.

Calcium. The intake of calcium fell off sharply with decreases in

the socio-economic ratings of the children according to each of the three arbitrary factors used. With respect to family cash income, the unit person requirement according to the Bureau of Home Economics of 0.68 grams of calcium daily was approached by the averages of the highest income group only, with sharp and consistent decreases in calcium intake for each successively lower income group. The average for the lowest income group was only about 50 per cent of the standard.

When the children were grouped as to cash income and distributed as to their level of calcium consumption, it may be seen in Figure 3, Sections 9, 10, 11, and 12, that 12.9 per cent of those in Income Groups A and B, combined, consumed 0.89 grams of calcium and above, with 29.0 per cent consuming from 0.88 to 0.69, 32.3 per cent from 0.68 to 0.49, 19.4 per cent from 0.48 to 0.29, and 6.4 per cent less than 0.29 grams per unit person, daily. The lower income groups showed a consistent tendency toward a decrease in the percentage in the groups of high calcium intake and an increase in the groups with lower intake, as income decreased.

Phosphorus. The intake of phorphorus was gradually less with lowering socio-economic status, although the decline was not so abrupt as that of calcium. The average of the highest two income groups (A and B, combined) slightly exceeded the Bureau of Home Economics unit person daily requirement of 1.32 grams of phosphorus, whereas Income Groups C and D were only slightly below this standard; Income Group E averaged but 75 per cent of the standard, approximately.

When the children were grouped as to family income and distributed as to phosphorus intake, as shown in Figure 3, Sections 13, 14, 15, and 16, it was found that 12.9 per cent of the children in Income Groups A and B, combined, were included in the highest arbitrary group of phosphorus intake (2.0 grams and above per unit person, daily), 41.9 per cent consumed from 1.99 to 1.50 grams, 41.9 per cent from 1.49 to 1.00, 3.2 per cent from 0.99 to 0.50, and 0.0 per cent below 0.50 grams of phosphorus per unit person, daily. The percentages of children in the higher phosphorus intake groups decreased gradually, but consistently, while those in the lower intake groups increased as income was less. Although no children in the first four income groups were found to consume less than 0.50 grams of phosphorus daily, 8.1 per cent of those in Income Group E received less than this amount.

Iron. The children showed gradual decreases in iron intake as family income, family education, and physical home rating decreased. In the income groups, the Bureau of Home Economics unit person requirement of 0.015 grams per day was met by the A and B combined groups, whereas the lowest income groups averaged approximately 75 per cent of the standard.

In iron intake, as seen in Figure 3, Sections 17, 18, 19, and 20, the number of children in Income Groups A and B, combined, receiving 0.020 grams of iron or above, per unit person, daily, was 6.4 per cent of the total, with 45.2 per cent consuming from 0.0199 to 0.0150 grams, 38.7 per cent from 0.0149 to 0.0100, 9.7 per cent from 0.0099 to 0.0050, and none consuming below 0.0050 grams. The other income groups displayed the same tendency as was indicated by the averages for iron, namely - a gradual decrease in the percentages of those in high iron intake groups, with an increase in those in the lower groups as incomes decreased.

Vitamin A. An abrupt decrease in vitamin A consumption was shown

with lowered family income, family education, and physical home rating classes. The highest two income classifications (Groups A and B, combined, and Group C) exceeded the Bureau of Home Economics standard of 6000 International Units of vitamin A per unit person daily, whereas the two lower income groups received slightly less than this standard. The results of the photometer tests, discussed in a later section of this report, indicate that the present standard may not be sufficiently high for optimum darkness adaptation response.

When the children were grouped as to cash income and distributed as to five arbitrary levels of vitamin A intake, Figure 3, Sections 21, 22, 23, and 24, show that 3.2 per cent of the children in Income Groups A and B consumed 24,000 International Units of vitamin A per unit person, daily, with 6.4 per cent consuming from 23,999 to 13,000, 58.1 per cent from 12,999 to 8,000, 25.9 per cent from 7,999 to 3,000, and only 6.4 per cent below 3000 International Units. A marked decrease was seen in the percentages of children in the higher vitamin A intake groups, with a corresponding increase in the lower intake groups as income became less.

Vitamin B_1. The average intake of vitamin B_1 was gradually less with lowered socio-economic status. When the children were grouped as to family cash income, for example, the A and B Income Groups, combined, reached the Bureau of Home Economics standard of 500 International Units of vitamin B_1, per unit person, daily, whereas Income Groups C and D averaged somewhat below the standard, and Group E received but 70 per cent of the standard, approximately.

When the children were grouped by family income and distributed as to level of vitamin B_1 intake, few in any income group were found to exceed the Bureau of Home Economics standard of 500 International Unite per unit person, daily. Figure 3, Sections 25, 26, 27, and 28, show that, in the highest income groups (Groups A and B, combined), for example, only 3.2 per cent of the children consumed 1000 International Units of vitamin B_1 or above, with none consuming from 999 to 750 International Units, although larger percentages of the children of some of the lower income groups fell in these two higher groups. It is seen that 48.5 per cent of the children in Income Groups A and B consumed from 749 to 500 International Unite of this vitamin, with 41.9 per cent receiving from 499 to 250 units, and only 6.4 per cent less than 250 International Units per unit person, daily.

Vitamin C. In vitamin C intake all socio-economic groups reached or exceeded the Bureau of Home Economics standard of 75 milligrams of ascorbic acid per unit person, daily, except the C group of physical home rating, which was but slightly below the standard. Since measurements of blood plasma ascorbic acid were not made on the children of this study for reasons already given, it is not known whether or not they were receiving adequate quantities of this vitamin, on the average. Recent blood ascorbic acid determinations in the same two communities from which the children for the study were selected indicate that the standard may not be sufficiently high for optimum blood values.

When the children were grouped as to income and distributed as to percentage intake of different levels of vitamin C, a consistent tendency was shown toward greater percentages of children from the higher income groups to be in the higher intake groups, and for greater percentages

from the lower income group to be in the lower intake groups as may be seen in Figure 3, Sections 29, 30, 31, and 32. In the highest income classification (Groups A and B, combined), 22.6 per cent of the children consumed 120 milligrams or more of vitamin C per unit person, daily, while 38.7 per cent consumed from 119 to 90 milligrams, 25.8 per cent from 89 to 60 milligrams, 129 from 59 to 30 and none below 30 milligrams. As mentioned, the percentages in the higher intake groups decreased and those in the lower groups increased as income became lower.

Riboflavin. Since analyses of many foods for riboflavin content have not been made, it is possible that the average intakes of this vitamin reported herein may be low. According to the data as found, the average intake of this nutrient by the children decreased as family income, family education, and physical home rating were lower, with all groups within each of the socio-economic sub-divisions below the present Bureau of Home Economics standards of 1.8 milligrams per unit person, daily.

When the children were grouped according to income and distributed by intake of riboflavin, as shown in Figure 3, Sections 33, 34, 35, and 36, the groups showed a consistent trend toward lower intakes of this vitamin with decreasing incomes. Incomes A and B combined had 3.3 per cent of the children in the arbitrary group of consumption of 1.80 milligrams of riboflavin and above; 30.0 per cent from 1.79 to 1.30 milligrams; 36.7 per cent from 1.29 to 0.80 milligrams, 23.3 per cent from 0.79 to 0.30 milligrams, and 6.7 per cent below 0.30 milligrams of riboflavin per unit person, daily. The lowest income group - Group E - on the other hand had 0.0, 5.4, 10.8, 40.5, and 43.2 per cent of the children in the respective intake groups of this vitamin, with the intermediate income groups showing intermediate decreases in percentages in the higher, and increases in the lower consumption classifications.

Although no standards for the requirements of the different nutrients are generally accepted at the present time, those of the Bureau of Home Economics, United States Department of Agriculture (10), are used most frequently in this country as points of reference. In Table 8 are shown these standards, together with the percentage of children in the various income groups above these standards for the nutrients under consideration.

RELATIONSHIP BETWEEN DIETARY INTAKE AND NUTRITIONAL STATUS

A knowledge of the inter-relationships between the intake of various nutrients and the responses to nutritional status tests of human beings is one of the major objectives of the long-time study of which the work described in this report was one unit. For purposes of the present study, the following possible relationships have been considered: the percentages of the children, in different groups classified according to nutritional rating by physical examination, which were found in different intake classes for all of the nutrients discussed in this study; the percentages of the children in different groups classified as to skeletal maturity classes, which were found in different intake classes of energy, protein, calcium, phosphorus, and vitamin A; the percentages of the children in different groups classified as to response to the biophotometer bright light factor, which were found in different intake classes of vitamin A; the percentages of the children in different groups classi-

fied as to biophotometer total integration factors, which were found in different intake classes of vitamin A; the percentages of the children in different groups classified as to hemoglobin content of the blood, which were found in different classes of iron and of protein intake. These distributions are shown in Figure 4.

From the data shown in Figure 4, it is apparent that 25.0 per cent of the children having a physical examination rating of 85 points or more consumed 2800 calories of energy or above, 41.6 per cent from 2799 to 2200, 25 per cent from 2199 to 1600, 8.3 per cent from 1599 to 1000, and none below 1000 calories per unit person, daily. In general, the percentages of the groups with high calorie consumption diminished from the higher to the lower intake groups as the physical examination ratings of the children became lower.

No consistent tendencies were seen in the distribution of the children with respect to protein intake classes when they were grouped according to their nutritional rating by physical examination. When the children in the three highest protein intake groups were considered together, however, 83.3 per cent of the children in the highest physical rating group were included in these combined classes, with 78.5, 76.2, 71.3, and 60.0 per cent of those in the succeeding physical examination classes, respectively, in the same combined protein intake classes. On the other hand, 16.7, 15.5, 23.8, and 40.0 per cent of the children in the two lowest protein intake groups, combined, were found in the respective physical rating classes in decending order.

Calcium intake showed no regular tendencies in the upper intake classes when the children were classified as to their physical examination ratings and distributed as to the percentage within each class consuming different amounts of calcium. When the lowest calcium intake was considered, however, only 8.3 per cent of the children in the highest physical examination rating class fell in the lowest calcium intake class, with 16.8, 17.9, 25.0,and 60.0 per cent of the children in the successive remaining physical examination classes, respectively, included therein.

No consistent tendencies with respect to phosphorus intake were observed for the various physical examination rating groups.

A slight tendency was observed for a larger number of children in the higher physical examination rating classes to occur in the highest two iron intake classes, and for a larger number of children in the lower physical examination classes to be found in lower iron intake classes. Thus, 13.0 per cent of the children in the highest physical rating class occurred within the highest two iron intake classes, with 3.5, 3.5, 3.7, and 0.0 per cent of the children in the succeeding physical rating classes coming within the two highest iron intake classes. Beyond these two iron intake classes, however, no regular tendencies were observed.

With respect to vitamin A intake by children of the various physical examination rating classes, the children in the first four classes of physical examination rating had approximately the same percentages in the two highest vitamin A intake classes, with no children from the fifth physical examination rating group in the highest two intake classes. On the other hand, no children from the first four physical examination rating groups were found in the lowest vitamin A intake class, while 20.0 per cent of the children in the fifth physical examination group occurred

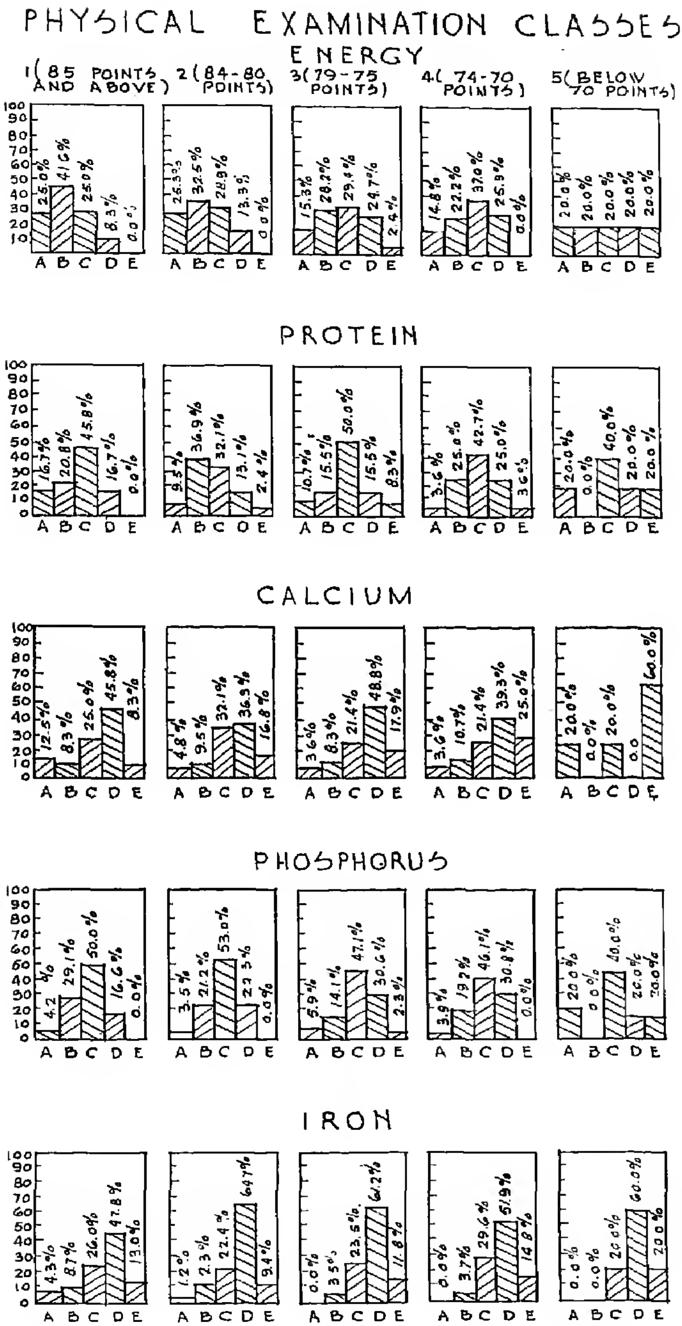


Fig. 4

For description see page 241.

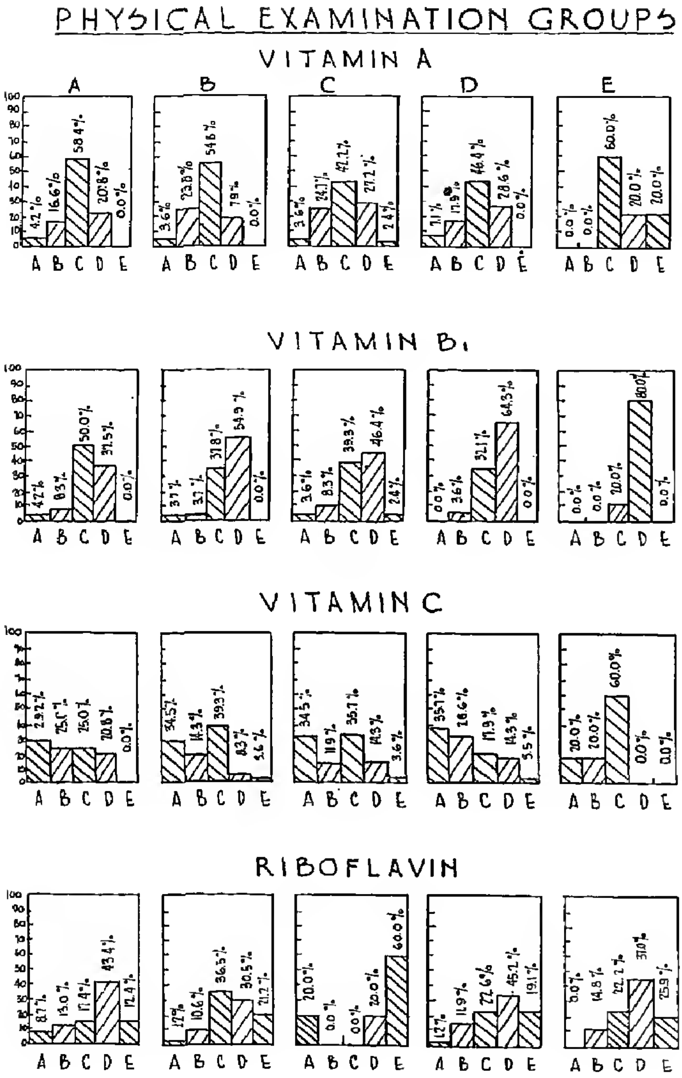


Fig. 4 (Continued)

For description see page 241.

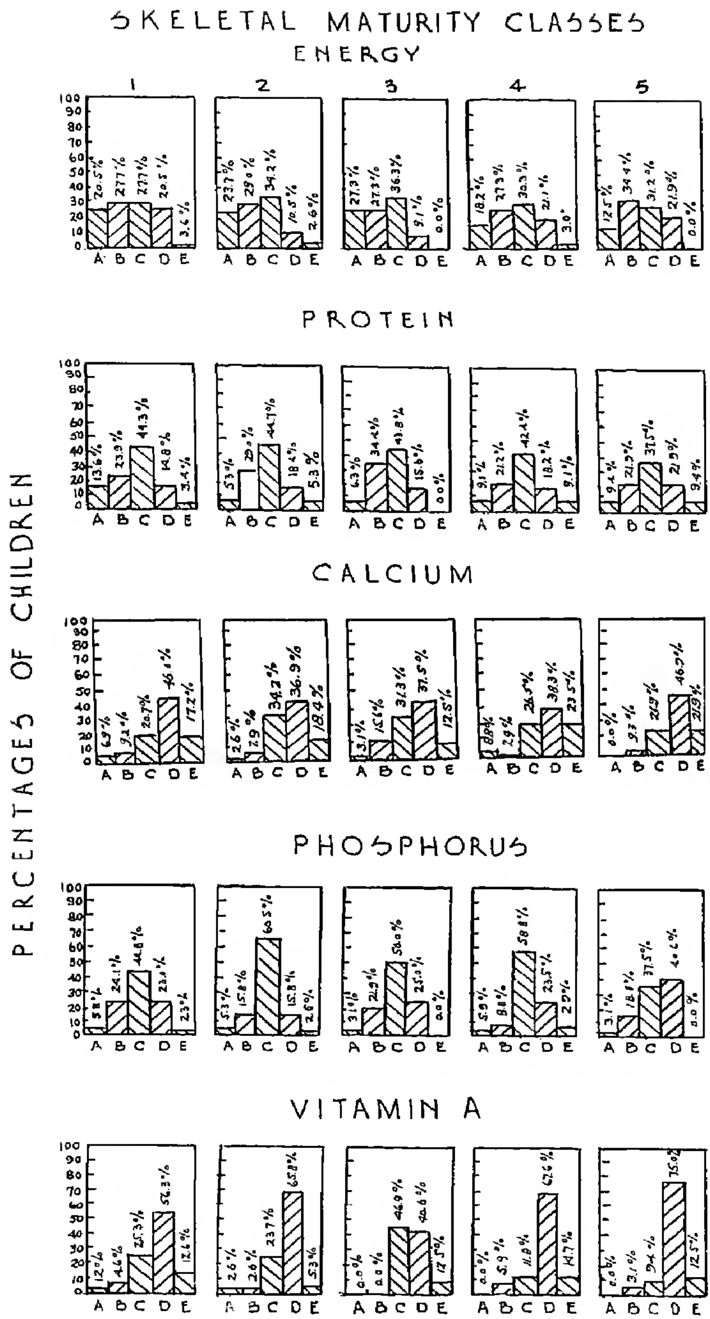


Fig. 4 (Continued) For description see page 241.

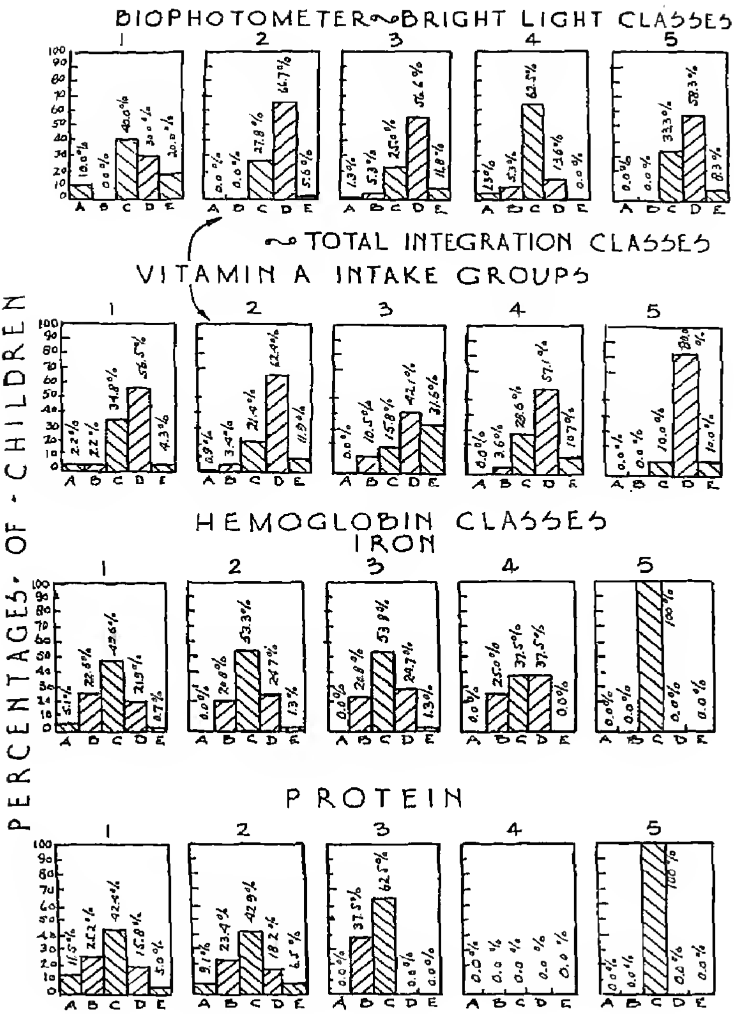


Fig. 4 (Continued)

For description see page 241.

Fig. 4. Distribution of Children, Grouped as to Nutritional Rating by Physical Examination, as to Percentages within the Different Arbitrary Energy, Protein, Calcium, Phosphorus, and Iron Intake Classifications.

Distribution of Children, Grouped as to Nutritional Rating by Physical Examination, as to Percentages within the Arbitrary Vitamin A, Vitamin B_1, Vitamin C, and Riboflavin Intake Classifications.

Distribution of Children, Grouped as to Skeletal Maturity Classes, as to Percentages within Different Arbitrary Energy, Protein, Calcium, Phosphorus and Vitamin A Intake Classifications.

Distribution of Children Grouped as to Biophotometer Bright Light Classes and separately as to Biophotometer Total Integration Classes, on the Basis of Percentages within Different Arbitrary Vitamin A Intake Groups.

Distribution of Children Grouped as to Hemoglobin Classes on the Basis of Percentages Within Different Arbitrary Iron and Protein Intake Groups.

in the same vitamin A intake class. Vitamins B_1, C, and riboflavin showed a distinct tendency toward larger percentages of the children in the higher physical examination rating groups also in the higher intake classes, with a larger percentage of children in the lower physical examination rating groups also in the lower intake classes.

To summarize, when the children were grouped according to their physical examination rating, the percentages in the higher nutrient intake classes were generally greater in the higher physical examination rating classes and vice versa.

When the children were classified according to their response to the skeletal maturity assay, no relationship was found between level of energy intake and skeletal maturity class.

The three highest skeletal maturity classes had a larger percentage of children in the two highest protein intake groups than was the case with the two lowest maturity classes. On the other hand, the two lowest skeletal maturity classes had a higher percentage of children in the two lowest protein intake groups than in the three highest groups. The same general trend was evident in the distribution of children according to calcium intake within the various classes of skeletal maturity.

No notable differences in phosphorus intake of children in the various skeletal maturity classes were evident except that a considerably lower percentage in the fifth class of skeletal maturity was found in the highest three groups of phosphorus intake, and a considerably higher percentage occurred in the lowest two groups of phosphorus intake, than in the higher skeletal maturity classes.

The percentages of children in the highest three classes of skeletal maturity were distinctly higher in the highest three vitamin A intake classes than in the lowest two classes. The percentages in the lowest two skeletal maturity classes, on the other hand, were markedly greater in the lowest two vitamin A intake classes than in the highest three classes.

When the children were grouped as to their biophotometer bright light factor classes, 50 per cent of the children in the highest bright light class occurred in the highest two vitamin A intake classes, and 50.0 per cent in the lowest three vitamin A intake classes, whereas none of those in the lowest bright light factor class occurred in the highest two vitamin A intake groups. The intermediate bright light response classes showed the same trend, in the main.

When the children were grouped as to their biophotometer total integration factors, the percentage of children in the highest total integration factor class in the highest three vitamin A intake groups, was 39.2 per cent, while that in the lowest test response group was 10.0 per cent in these high intake groups. The reverse was true with respect to the percentage in the lower vitamin A intake groups.

When the children were classified according to hemoglobin status, no definite tendency was shown with respect to iron or protein intakes for those in the different hemoglobin groups.

The comparison of responses to certain of the nutrition tests and intake of various of the nutrients indicates that lowered nutritional rating as measured by these tests was undoubtedly associated with undesirably low intakes of various of the nutrients. The interrelationships are complicated, however, and they await further analysis before they can be more clearly explained. From the evidence in hand, nevertheless, both the responses to the nutrition tests and the analysis of the dietary intakes of the children clearly indicate the need for improvement in nutritional status of a considerable proportion of the children in all socio-economic groups, with this need becoming more acute as the socio-economic level becomes lower.

PLANNING A MID-DAY MEAL FOR CHILDREN IN VARIOUS INCOME GROUPS

A rational approach to the subject of improving the nutritional status of children of school age would be the feeding of a mid-day meal which would supplement the morning and evening meals which are being fed to the average children in various socio-economic groups. With annual family cash income as a measure of socio-economic status of urban children, Figure 5 has been drawn to show the average daily intake of the children per unit person for breakfast and dinner, combined, for each of the nutrients considered in this report, and the amounts of each of the nutrients needed by each income group, on the average, to meet the Bureau of Standards requirement for that nutrient. In the figure, the average intakes (per unit person, daily) for breakfast and dinner of the respective nutrients are shown at the left of each section of the graph, with the Bureau of Home Economics standard for that nutrient (marked A) shown in the same section. At the right in each section, the needed amount of the nutrient to bring each income group up to the present standard is shown, and is designated as I. L., abbreviated from ideal lunch. In the case of vitamin A, the Bureau of Home Economics standard is given, as in the other cases, and a higher value, 8000 International Units as suggested by Mack and Sanders (7) to be associated with the highest class of response to a photometer test, also is shown (marked A_X). The ideal lunch needed to supply each of these quantities is shown, that for the Bureau of Home Economics standard being labeled in the usual manner, and that for supplying 8000 International Units per unit person, daily, being marked I. $L._X$.

In determining what should be the nutrient content of a school lunch offered for sale, the data graphed in Figure 4 indicate the desirability of stressing intake of protein, calcium, phosphorus, iron, and the various vitamins, while minimizing the foods which furnish energy as their

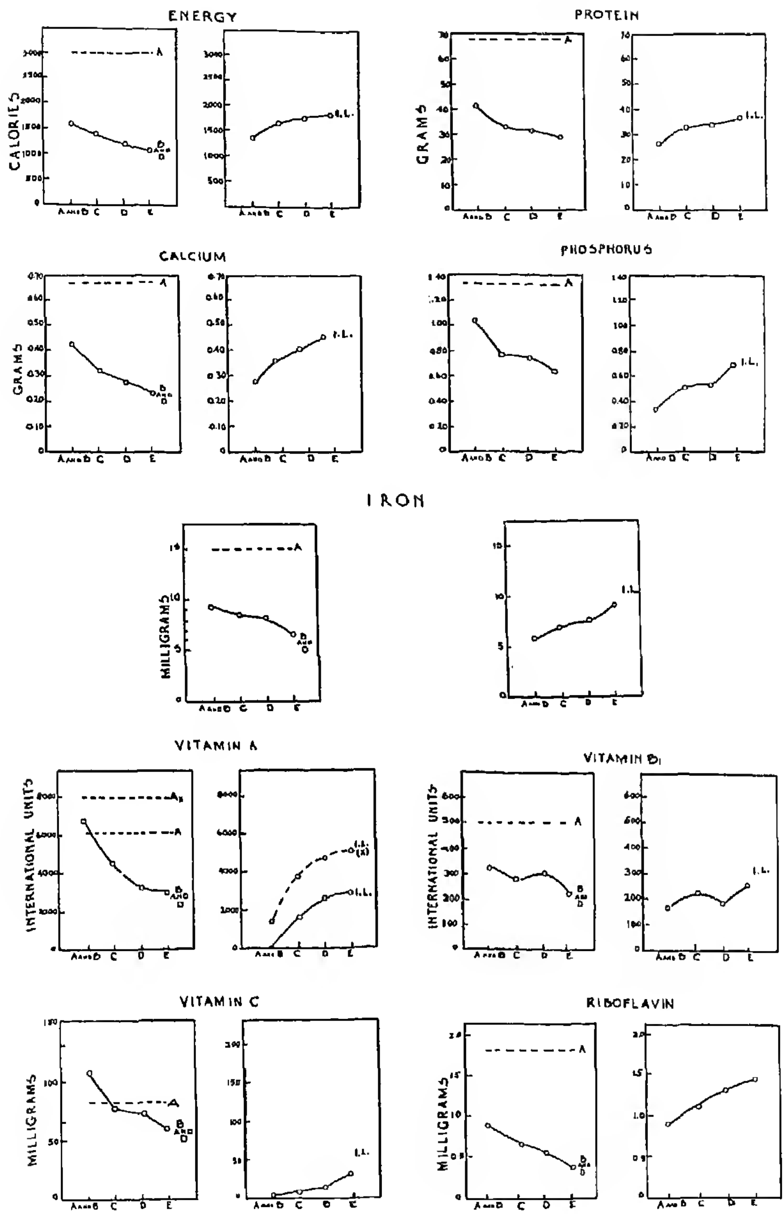


Fig. 5. (Left) Average Intakes of Nutrients During Breakfast and Dinner Combined (B and D), In Comparison with Bureau of Home Economics Standards (A) for the Respective Nutrients, with the Children Classified by Income Groups.

(Right) Average Requirement of an Ideal Lunch (I. L.) which would supplement Breakfast and Dinner, Combined, and bring Them Up to the Standard.

chief contribution. The opposite frequently is done in school organizations in which a limited budget is available for maintaining the school lunch. Careful planning, however, will make it possible to supply the nutrients most likely to be inadequate in the home diets at a small cost.

Where school lunches are to be made available at no cost to the child, either through the use of surplus commodities or otherwise, the question then arises as to what children in the school shall receive the lunch. It is evident from the data presented in this report that need for such a lunch for the purpose of supplementing an otherwise inadequate home diet becomes progressively greater as such factors as family income and family education become lower. Nevertheless, the percentage of children in the higher socio-economic groups meeting the Bureau of Home Economics dietary intake standards is not high, and therefore a school lunch high in protein, minerals, and vitamins at no cost to the child would seem to be a desirable ideal. The percentages of children in this study in each income group meeting the standard for the nine nutrients considered in this report are shown in Table 8.

The two most striking points in connection with the data in this table are the following: first, the percentages of children in the highest income group - A and B, combined - meeting or exceeding the standards for all nutrients except vitamins A and C (in which cases the standards may be too low) are comparatively small; and second, the percentages of children meeting or exceeding the standards generally fall off sharply with family income.

From the ideal point of view, a mid-day meal supplying the nutrients most likely not to be received at home should be provided at school to all children shown by objective nutritional tests to be in need thereof. From practical considerations, however, it will probably not be possible

TABLE 8

PERCENTAGE OF CHILDREN OF DIFFERENT INCOME GROUPS WHO MET OR EXCEEDED THE BUREAU OF HOME ECONOMICS STANDARDS FOR INTAKE OF VARIOUS NUTRIENTS

Bureau of Home Economics Standard for Nutrient Intake Per Unit Person, Daily	Percentage of Children Meeting or Exceeding Standard in Their Three-Meal Daily Intake.			
	Income Groups A and B	Income Group C	Income Group D	Income Group E
Energy 3000 calories	35.5%	9.7%	5.4%	0.0%
Protein 67 grams	32.2%	20.8%	16.1%	2.7%
Calcium 0.68 grams	51.6%	14.9%	7.1%	5.4%
Phosphorus 1.32 grams	51.6%	33.7%	33.9%	18.9%
Iron 0.0150 grams	51.6%	22.6%	26.7%	10.8%
Vitamin A 6000 International Units	80.6%	46.5%	41.1%	27.0%
Vitamin B_1 500 International Units	51.7%	29.7%	23.3%	16.2%
Vitamin C 75 Milligrams	93.5%	72.3%	67.9%	56.8%
Riboflavin 1.8 milligrams	16.1%	3.0%	3.6%	2.7%

for some time to test all of the children in many school systems. The problem then resolves itself into which, if any, children to feed at school for the purpose of improving nutritional status.

If lunches are supplied at nominal cost or without cost to all grade school children, one or the other of the following plans seems worthy of recommendation:

(1) The amounts of each of the nutrients in the ideal lunch for the lowest income group in Figure 5 may be fed to all children, so that the lowest income group and the most poorly nourished children in the other income groups may receive the articles of diet needed for nutritional adequacy. Parents of the children could simultaneously be instructed as to the diets being given at school, and as to recommended dietarics for the morning and evening meal needed to complement the mid-day intakes.

(2) Amounts of the nutrients mid-way between that needed in the ideal lunch for the highest and that for the lowest incomes could be served, with parental instruction given as to the morning and evening requirements.

(3) Only children in the two lowest income groups could be fed, the daily mid-day amounts being that of the lower of the two groups in the case of each nutrient.

In considering either the first or third suggestion, the question arises as to whether or not, in one meal, the quantities of the different nutrients required to supplement the morning and evening meals of the children of the lowest income group would be possible from the practical point of view. Taking the higher amount of each nutrient needed to be added to the average breakfast and dinner intakes for the two lowest income groups, the ideal lunch needed to supply these amounts would contain approximately: 1660 calories of energy, 34 grams of protein, 0.45 grams of calcium, 0.70 grams of phosphorus, 0.082 milligrams of iron, 2592 International Units of vitamin A, 271 International Units of vitamin B_1, 22 milligrams of vitamin C, and 1.39 milligrams of riboflavin, per unit person. In order to calculate these values to the basis of children of different ages, the unit person content of a group should be ascertained by assigning to each child, in the group, according to sex and age, the unit equivalent for each of the nutrients, as shown in Table 1 of this report. The sum of these units gives the unit person content of the group with respect to each of the nutrients.

Suppose, for example, a school group is composed of 20 children, including 9 boys and 11 girls. One of the boys is 8, six are between 9 and 10, and two are 11 years of age. Six of the girls are between the ages of 8 and 10, one is 7, and four are from 11 to 12 years of age. Table 9 presents the calculation of the unit person content of the group for each of the nutrients, and the method of ascertaining the approximate quantity of each nutrient required for the ideal lunch to supplement the home diets of children in the two lowest income groups as recommended on the basis of the data presented in this report.

The quantity of nutrients included in a mid-day meal suggested by this study are higher than those recommended for nursery school children by Hann and Stiebeling (3), probably because many of the subjects in the present study come from lower income families than those of the other investigators.

TABLE 9

METHOD OF CALCULATING DESIRABLE NUTRIENT CONTENT OF MID-DAY MEAL FOR CHILDREN FROM FAMILIES ON LOW INCOMES

Number	Sex	Age	Unit Factors for Various Nutrients: Energy	Protein	Calcium	Phosphorus	Iron	Vitamin A	Vitamin B1	Vitamin C	Riboflavin
1	M	8	0.7	1.0	1.6	0.8	0.7	0.9	0.7	0.7	0.9
6	M	9-10	(0.8 x 6) 4.8	(1.1 x 6) 6.6	(1.5 x6) 9.0	(0.9x6) 6.4	(0.8 x6) 4.8	(0.9x6) 5.4	(0.8x6) 4.8	(0.8x6) 4.8	(0.9x6) 5.4
2	M	11	(0.83x2) 1.66	(1.1 x 2) 2.2	(1.5 x2) 3.0	(0.9 x2) 1.8	(0.9 x2) 1.8	(1.0x2) 2.0	(0.83x2) 1.66	(0.9x2) 1.8	(1.0x2) 2.0
1	F	7	0.5	0.8	1.5	0.8	0.6	0.75	0.5	0.7	0.75
6	F	8-10	(0.7 x 6) 4.2	(1.0 x 6) 6.0	(1.5x6) 9.0	(0.8x6) 4.8	(0.7x6) 4.2	(0.9x6) 5.4	(0.7x6) 4.2	(0.7x6) 4.2	(0.9x6) 5.4
4	F	11-12	(0.8 x 4) 3.2	(1.1 x 4) 4.4	(1.5x4) 6.0	(0.9x4) 3.6	(0.8x4) 3.2	(0.9x4) 3.6	(0.8x4) 3.2	(0.8x4) 3.2	(0.9x4) 3.6
Total for the Group			15.06	21.0	30.0	17.2	15.2	18.05	15.06	15.4	18.05
Average for the Group			0.76	1.06	1.60	0.86	0.76	0.90	0.76	0.77	0.90
Needed Content per Child for Mid-Day Lunch[1] (Per Unit Person Need X Average Unit Factor)			(1660x0.75) 1246 calories	(34x 1.05) 36 grams	(0.45 x 1.6) 0.68 grams	(0.7 x 0.86) 0.60 grams	(0.0082 x 0.76) 0.0062 grams	(2392 x 0.9) 2333 International Units	(271 x 0.76) 203 International Units	(22 x 0.77) 17 Milligrams	(1.39 x 0.9) 1.25 Milligrams

[1]Calculated on the basis of the needs of the two lowest income groups in order to supplement the average content of the *morning and evening meals.*

The authors have calculated many dietaries which would serve as practical lunches supplying approximately the quantity of the nutrients per unit person, daily, which would be needed on the average for the two lowest income groups as shown by the data of this report, and exemplified in Table 9. The diets included a wide variety of foods, so that there would be no need for monotony. Foods which frequently constitute surplus commodities were found to fit well into a planned mid-day meal intended to be high in proteins, minerals, and vitamins, the need for which was indicated by these findings. In many cases, the menus which supplied desirable amounts of energy, protein, calcium, phosphorus, and iron were higher in certain of the vitamins, particularly vitamin A and vitamin C than is called for to supplement the home morning and evening meals of the low income group of children in question according to the standards used. It was not deemed undesirable by the authors to allow these factors to be higher than is indicated in Table 9, however, because it is believed that the present standards for these factors may be found to be too low.

It is planned by the authors to continue the study and to measure these or similarly selected children for nutritional status periodically while supplying the type of mid-day meal suggested in this report.

SUMMARY

Two hundred and twenty-five children were selected from two urban communities to find from dietary records and nutritional status measurements what should constitute a satisfactory noon-day meal to supplement the morning and evening diets of children of different socio-economic groups. Details are presented concerning the diets of the children and their responses to the various nutritional status tests, and recommendations concerning the nutrient content of a school lunch are made.

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AN ANALYSIS FOR MULTIPLE FACTORS OF PHYSICAL GROWTH AT DIFFERENT AGE LEVELS[1]

C. H. McCLOY[2]

Many students of human growth have observed not only that there are rhythms of growth, but also that one type of growth seems to predominate at one time and another type of growth at another time. Thus, at the onset of adolescence, a spurt of growth of the long bones is often seen, which is followed later by an acceleration of growth of the cross-sectional measurements. Meredith (6) and Boynton (1) have both shown that the growth rate of subcutaneous fat tends to be reduced when linear and cross-sectional growth rates are accelerated, while the growth rate of fat accelerates when linear and cross-sectional growth rates decline.

Such observations suggest a number of questions like the following:

1. How many distinct types of growth are exhibited by the human body?
2. Can these types of growth be isolated and identified?
3. Is growth in certain dimensions a compound? If so, of which growth factors is it compounded, and in what proportions?
4. Are there marked age differences in these different types of growth as they affect each measurement?
5. In the light of the facts, what can we learn that would help us to solve the problem of classifying body types for different purposes?

If it is possible to resolve growth into such relatively clear-cut factors or types of growth, the knowledge of these factors should aid measurably in facilitating the solution of many problems of physical anthropology as they apply to the growth of the child.

In the light of some recent mathematical publications it would seem that such methods for separating and isolating growth factors are available. The stimulus for the invention of such methods came from the two-factor theory of Spearman. Spearman (7), in 1927, published a method of separating a number of variables into one general or common factor, plus a number of specific factors, the number of which specific factors was the same as the number of variables. The application of this method was restricted to such variables as possessed only one general or common factor. Many of the mental tests to which this method was applied, together with a large number of motor tests and growth variables, were seen to possess a large number of such common factors. In 1928, T. L. Kelley (4) proposed a method which extended the Spearman method to more than one general factor, but this method had other limitations which discouraged its use.

More recently two methods have been devised, each of which seems to have no limitations as to the number of factors common to all the variables or to any group of them. Either seems to be satisfactory. The first of these two methods, that presented by L. L. Thurstone (8), pre-

[1] *Much of the expense of the statistical computations connected with this study was financed by a grant from the Carnegie Foundation for the Advancement of Teaching.*

[2] *From State University of Iowa.*

CHILD DEVELOPMENT, Vol. 11, No. 4 (December, 1940)

AN ANALYSIS FOR MULTIPLE FACTORS OF PHYSICAL GROWTH AT DIFFERENT AGE LEVELS[1]

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Many students of human growth have observed not only that there are rhythms of growth, but also that one type of growth seems to predominate at one time and another type of growth at another time. Thus, at the onset of adolescence, a spurt of growth of the long bones is often seen, which is followed later by an acceleration of growth of the cross-sectional measurements. Meredith (6) and Boynton (1) have both shown that the growth rate of subcutaneous fat tends to be reduced when linear and cross-sectional growth rates are accelerated, while the growth rate of fat accelerates when linear and cross-sectional growth rates decline.

Such observations suggest a number of questions like the following:

1. How many distinct types of growth are exhibited by the human body?
2. Can these types of growth be isolated and identified?
3. Is growth in certain dimensions a compound? If so, of which growth factors is it compounded, and in what proportions?
4. Are there marked age differences in these different types of growth as they affect each measurement?
5. In the light of the facts, what can we learn that would help us to solve the problem of classifying body types for different purposes?

If it is possible to resolve growth into such relatively clear-cut factors or types of growth, the knowledge of these factors should aid measurably in facilitating the solution of many problems of physical anthropology as they apply to the growth of the child.

In the light of some recent mathematical publications it would seem that such methods for separating and isolating growth factors are available. The stimulus for the invention of such methods came from the two-factor theory of Spearman. Spearman (7), in 1927, published a method of separating a number of variables into one general or common factor, plus a number of specific factors, the number of which specific factors was the same as the number of variables. The application of this method was restricted to such variables as possessed only one general or common factor. Many of the mental tests to which this method was applied, together with a large number of motor tests and growth variables, were seen to possess a large number of such common factors. In 1928, T. L. Kelley (4) proposed a method which extended the Spearman method to more than one general factor, but this method had other limitations which discouraged its use.

More recently two methods have been devised, each of which seems to have no limitations as to the number of factors common to all the variables or to any group of them. Either seems to be satisfactory. The first of these two methods, that presented by L. L. Thurstone (8), pre-

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sents considerably less difficulty in computation than does the second, that proposed by Hotelling (3). With known communalities inserted in the diagonals of the correlation matrix before computation,[3] the two methods give identical results. Both methods require rotation before the factor loadings become meaningful. A recent study has shown that with unknown communalities, the Thurstone method gives the more accurate results (5).

When this method of factor analysis is applied to a number of variables, such as the anthropometric measurements used in this study, the end result of the computations after rotation consists in a number of "factor loadings" which are, in effect, zero-order correlations with each of the isolated factors. These computations may be carried out to a relatively large number of factors, in which case it is highly probable that the first few will be factors common to all or to a large part of the variables, while, as the number of these isolated factors increases, their correlations with the individual variables give indications that the succeeding factors are relatively specific to a very small number of variables. In the present study, three important factors common to a relatively large number of variables have been isolated or tentatively identified, and a fourth factor is present in most of the age groups. The factor seems to be a minor group factor, and the loadings are very small in size.

If all of the factors of growth, common and specific, were measured and isolated by this method, and if there were no errors of measurement (in other words, if there were perfect reliability and objectivity of measurement), the sum of the squares of all of the factor loadings of a given variable would be unity. It will be seen that this is not the case in this study. The sum of the squares of some of these factor loadings approaches unity. Others are only partially accounted for. The difference is compounded of two elements. The first is any factor or factors specific to that particular measurement.[4] The second consists of "errors," or unreliabilities of the measurement. For example, the reliability and the objectivity of weight are almost perfect. There is considerable variation, however, in the measurement of shoulder width, which is so much affected by the way in which the shoulders are held by the individual, and of breathing capacity, which is almost as much of a mental test for many very young individuals as it is a test of the amount of air that can be exhaled from the lungs.

MEASUREMENTS TAKEN

All, or a large proportion, of the following measurements were obtained upon the several age groups in both sexes:

1. WEIGHT
2. TOTAL HEIGHT
3. SITTING HEIGHT
4. BI-ACROMIAL WIDTH OF THE SHOULDERS
5. BI-CRISTAL WIDTH OF THE HIPS

[3] *The communality for any variable is the sum of the squares of all of the factor loadings for the variable.*

[4] *It should be remembered that a factor may be specific to one variable in one battery, and common to several or all variables in a different battery.*

6. WIDTH OF CHEST
7. DEPTH OF CHEST
8. GIRTH OF CHEST (All chest measurements were taken at the level of the xiphoid.)
9. BREATHING CAPACITY OF THE LUNGS
10. WIDTH OF LEFT ELBOW AT THE EPICONDYLES
11. WIDTH OF LEFT KNEE AT THE EPICONDYLES
12. GIRTH OF LEFT UPPER ARM, EXTENDED DOWNWARD
13. GIRTH OF LEFT FOREARM
14. GIRTH OF LEFT THIGH
15. GIRTH OF LEFT CALF
16. SKIN AND SUBCUTANEOUS FAT THICKNESS ON THE LEFT FRONT OF CHEST (at the xiphoid level, midway between the sagittal planes running through the left axilla and the sternum, respectively)
17. SKIN AND SUBCUTANEOUS FAT THICKNESS OVER THE BACK (at the xiphoid level, over the most prominent swelling of the left erector spinae)
18. SKIN AND SUBCUTANEOUS FAT THICKNESS ON THE FRONT OF THE LEFT ARM (over the biceps, midway between the acromion and the elbow)
19. SKIN AND SUBCUTANEOUS FAT THICKNESS OVER THE LEFT TRICEPS (midway between the acromion and the elbow)

These measurements were all intercorrelated and then analyzed by Thurstone's center of gravity method of factor analysis, and rotated by the two-at-a-time method of successive rotations.

PRELIMINARY STUDY

Preliminary studies were made upon two groups. These two groups were composed of Freshman men and women at the State University of Iowa (see College Ages, Tables 1 - 20).[5] Ages ranged from eighteen years to twenty years. In this study five factors were computed in order to determine how many significant factors might be isolated. Four of these were felt to be of considerable significance. The fifth was small and gave little promise of being significant so far as the isolation of a common or group factor was concerned.

THE MAIN STUDY

After this preliminary study was completed, similar data were analyzed for the following additional age groups:

Boys, ages 9 days, and 4, 6, 8, 10, 12, 14, and 16 years
Girls, ages 9 days, and 4, 6, 8, 10, 12, 13, 15, 16, and 17 years.

In each of these groups the computations were carried out to five factors, and if the fifth factor seemed at all promising, to a sixth factor. The fifth and sixth factor residuals were, of course, computed in such cases. In the final analysis, however, none of the factors beyond

[5] *It should be remembered that many of the differences in the factor loadings from age to age are explainable in terms of sampling. Factor loadings are functions of intercorrelations. It is well known that in successive samples of the same population the intercorrelations will vary to a considerable extent. This should be kept in mind in studying these factor loadings.*

the fourth seemed significant.[6] In each age group the same three factors appeared, and in almost all the groups the fourth factor was evident. In the analysis for these factors the measurements of fat and subcutaneous tissue seemed, on the whole, to be the least complicated. These four measurements stood out in one factor, and were almost always well grouped. Hence, in rotating we ran one plane through them, and have called this factor that of "growth in fat." It is, in each case, the first factor.

The second factor is that which is weighted highest in the linear measurements, such as in height and sitting height. In other studies on adults (see later in this paper) this factor is also high in lengths of upper arm, forearm, lower leg, foot, etc. It is practically orthogonal to the fat factor, and not compounded significantly with it. Almost all variables, except the fat measurements, have some significant loadings with this factor. In view of the high loadings in the variables that represent linear growth (lengths and height), we were tempted to call it a "linear growth factor." In view, however, of the fact that it is present in almost all variables except fat, we shall tentatively call it a "general growth factor." This latter assumption seems to be substantiated by a subsequent study discussed below.

The third factor is one that is most heavily loaded in the girths, widths, and depths. In general, it has its heaviest loadings in the limb girths: arm, forearm, thigh, and calf, and next in the girth, width, and depth of the chest. All of these, except the chest width, have much muscular tissue inclosed within the tape or calipers; but in view of the fact that, as measured, the chest width does not include any significant amount of muscular tissue in the measurement, we are not justified in calling it a "muscle factor." We shall call it, for convenience, the factor of "growth in cross section" or the "cross-sectional factor." For the present this term may be considered as descriptive and not explanatory. This factor is seldom seen in pure form, for the variables that are weighted with this factor are also weighted with the fat factor since fat also lies under the tape or calipers.

The fourth factor is not entirely consistent. It might be thought to consist purely of deviations from a residual plane if the variables found loaded most heavily with it in the various age groups were not the same ones. It is usually most heavily loaded in the variables of chest girth, depth, and width, and sometimes in the width of the shoulders. It is, however, the least consistent factor, and varies the most. We shall make no attempt to name it, but shall simply call it "Factor IV."

It may be interesting to note that Growth Factor II (general growth) is of such a nature that if it were functioning strongly and the other three factors were not, the individual's build would be linear or asthenic. Growth Factor III, (cross-sectional growth) functioning heavily, would produce a lateral or pyknic build. Growth Factor IV would add a tendency toward Kretchmer's athletic type of build - large chest and wide shoulders.

In this study the data are presented in two ways. First, the rotated factor loadings are given as obtained. In this set of factor loadings there are numerous divergencies from age to age in the same sex. To attempt to iron out adventitious variations, these loadings were smoothed

[6] The judgment of "significance" was based on the size of the residuals and upon whether or not such a factor seemed identifiable.

twice by the method of running averages. Both were plotted for study (one variable at a time being plotted for all four factors over the whole age range). In Tables 1-20, both of these loadings are given. The original loadings are given in roman type, and the smoothed loadings are underlined at the lower right.

With minor differences, the variables fall into six groups:

1. WEIGHT AND BREATHING CAPACITY
2. HEIGHT AND SITTING HEIGHT
3. WIDTHS OF SHOULDERS, HIPS, ELBOWS, AND KNEES
4. DEPTH, WIDTH, AND GIRTH OF THE CHEST
5. LIMB GIRTHS
6. FAT MEASUREMENTS

Of these groups, the chest and the limb girth groups have much in common.

The trends within these groups are discussed below. The approximate "average factor loadings" are taken by inspection from the smoothed loadings. The actual loadings, both raw and smoothed, may be obtained from Tables 1-20. Charts 1-12, illustrating a number of the factors, both in their original form and smoothed, are presented as an aid to understanding the nature of the results.

1. Weight and Breathing Capacity. In our data we do not have breathing capacity records for children under eight years of age. The factor loadings for weight and breathing capacity resemble each other in that the general growth factor is the most heavily loaded in both. For weight, this averages a factor loading from .65 to .70 in both sexes; but falls off somewhat after puberty. In breathing capacity this factor has a factor loading that averages about .65 to .70 in boys and between .55 and .65 in girls. The loadings fall off after puberty in both sexes.

As would be expected, the fat factor has moderate factor loadings with weight - from .35 to .40 in boys, and from .45 to .60 in girls. In breathing capacity it is approximately .00 in both sexes.

The cross-sectional factor is moderately high in both measurements - averaging for weight from .45 to .60 in both sexes, and from .20 to .25 in breathing capacity.

Factor IV is negligible both in weight and breathing capacity.

2. Height and Sitting Height. These measurements are very heavily weighted with the general growth factor, and with very little else. The factor loadings for this factor for height run from .90 to .98 for boys, except for the infants in both sexes. Those for sitting height vary around an average of .85 for both sexes. For some reason the fat factor is fairly high in height (beyond logical expectancy) at the nine-days old level - up to .60 in boys and .30 in girls. It does not appear significantly in this measurement after that.

3. Measurements of Widths of Shoulders, Hips, Elbows, and Knees. These measurements have much in common. The fat factor is very lightly weighted in all though it is more in evidence in the girls than in the boys. In the boys it runs from an average of .15 (shoulders and elbows) to an average of .25 (hips and knees). In the girls it averages about .25 and .35 for these two groups, respectively.

The general growth factor, the one most concerned in linear growth, is the one that is most prominent in all forms of these measurements.

The reason for this is evident in the case of the shoulder width. If one remembers that hip width varies essentially as the product of twice the length of the innominate bones and the sine of the angle of those bones with the sagittal plane, it will be seen that hip width is really a "linear" measurement.

The logic of the relationship between the widths of the elbow and knee to this type of growth is not clear, but the fact remains that in almost all age groups this type of growth is predominant in these measurements.

The cross-sectional growth factor loadings for these measurements average about .30 with various fluctuations. Type IV is present only in shoulder width, except for hip width in girls, and it is low in all of these measurements, seldom averaging above .20 to .25.

There is a very slight tendency for the general growth factor and the cross-sectional growth factor to alternate: that is, when the one goes up, the other goes down. It is not clearly evident throughout, however, and may be merely a function of the sampling.

4. Measurements of the Chest. These measurements are significantly weighted with all factors. The fat factor varies from an average of .20 to one of .50, with a general average of nearly .40. The cross-sectional factor has weightings that average from .40 to .60, with a general average of about .50. The general growth factor varies from an average of about .30 to one of .55, but tends to fall off by the time the individual is eleven or twelve years of age. Factor IV here shows fairly significant loadings, running from an average of .22 to one of .60. The general average is low before the age of ten or twelve - about .25 - but increases to a general average of nearly .50 at the college ages. It is in this group of measurements that this factor is most prominent.

Factor IV and the cross-sectional factor tend to vary inversely: that is, when the cross-sectional factor increases, the fourth factor tends to diminish; and vice versa.

5. Limb Girths. In these measurements each of the first three factors is fairly heavily weighted. Since there is subcutaneous fat under the tape, as would be expected, the fat factor is rather prominent, averaging, in the different measurements, from .40 to .65, with a general average of about .55. This tends to fall off somewhat in the case of individuals over ten and twelve years of age.

What we have called the cross-sectional factor has average weightings from .50 to .65, with a general average of somewhat over .55. This tends to increase after the individual is ten to twelve years of age.

The general growth factor also is well represented, especially in the ages before ten. It has weightings averaging from .30 to .50, with a general average of about .40. It tends to fall off in girls over twelve years of age and in boys over fourteen years of age.

There are no significant loadings with the fourth factor in any of these variables.

There is a slight tendency, especially with the boys, for the general growth and the cross-sectional factors to vary inversely: that is, as the general growth factor increases, the cross-sectional factor diminishes, and vice versa. This tendency is not quite as marked with the girls.

These last two groups of measurements - the chest measurements and

the limb girths - have much in common, especially the heavy loadings with cross-sectional and general growth factors. The limb girths, however, are not significantly weighted in the fourth factor, and tend to show a heavier weighting in the fat factors, possibly because fat in these smaller measurements is a larger part of the whole cross-section.

6. <u>Measurements of Fat and Subcutaneous Tissue.</u> In these measurements there is only one factor of importance - what we have called the "fat factor." The factor loadings for this fat factor average from .70 to .80 for all ages and both sexes. The trunk fat gives consistent loadings of about .80 for both sexes as do the measurements of fat on the arms for the boys. In the girls, this drops on the arms to about .70. The other three factors fluctuate around loadings of zero, and are not significant. These measurements seem to be relatively pure in this factor.

Further light is thrown upon the nature of Factor II (the general growth factor) by the analysis of data obtained from the Bureau of Home Economics, the Department of Agriculture of the United States Government. This Department has conducted an anthropometric study of children of both sexes, four to seventeen years of age, inclusive, for the purposes of standardizing clothing measurements. The author was associated with this study in its preparation and was the director of the study for the state of Iowa. He has knowledge that the measurements were accurately taken.

In this study no fat measurements were taken, and all ages were combined for the intercorrelations. These correlation matrices were factored in this laboratory. Only two factors of sure significance could be isolated. When rotated, these seem to be Factor II (the general growth factor) and Factor III (the cross-section factor). It is significant that in this study over such a large age range, the general growth factor was present in very large measure in <u>all</u> of the measurements, cross-sectional or linear. The results are shown in Table 21, where the factors of the boys are shown in roman type at the upper left, and those of the girls are underlined at the lower right.

After the analyses presented above had been studied, a number of questions presented themselves. Hence two other anthropometric studies of adult male and female college students were projected. Thirty-two measurements were analyzed in the first study on males, and thirty-seven measurements in the study on females. The age range of males was from seventeen to twenty-two years, and of the females from seventeen to twenty-one years. The measurements on the males were taken by Dr. W. W. Massey, and those on the females by Dr. Ruth I. Bass, who at that time were cooperating with the writer in anthropometric studies for other purposes.

The measurements both for males and females were factored to seven factors. In the males the residuals beyond the fourth factor become very small, and in the females those beyond the fifth factor become very small. Plots of each of the subsequent factors against each of the others gave no indications of possessing significance.

The measurements studied were as follows:

1. WEIGHT
2. HEIGHT
3. SITTING HEIGHT (males only)

4. SITTING HEIGHT TO CERVICALE
5. PROJECTED LENGTH, CERVICALE TO LUMBALE
6. LENGTH STERNUM
7. LENGTH UPPER ARM, ACROMION TO RADIALE
8. LENGTH FOREARM, RADIALE TO STYLION
9. LENGTH HAND
10. LENGTH LOWER LEG, TIBIALE TO SPHYRION
11. LENGTH FOOT
12. LENGTH CLAVICLE
13. LENGTH FROM STERNAL END OF CLAVICLE TO ACROMION
14. LENGTH 10th RIB, FROM SPINE OF 9th RIB TO JUNCTION WITH COSTAL CARTILAGE (measured around the thorax with a tape)
15. WIDTH SHOULDERS
16. WIDTH HIPS (at iliocristale)
17. WIDTH HIPS (at iliospinale anterior)
18. WIDTH TOP OF ILIUM FROM ILIOSPINALE ANTERIOR TO ILIOSPINALE POSTERIOR
19. WIDTH ELBOW
20. WIDTH KNEE
21. DEPTH CHEST AT XIPHOID
22. WIDTH CHEST AT XIPHOID
23. GIRTH CHEST AT XIPHOID
24. GIRTH NECK
25. GIRTH UPPER ARM
26. GIRTH FOREARM
27. GIRTH THIGH
28. GIRTH CALF
29. BREATHING CAPACITY OF THE LUNGS
30. FAT, CHEST FRONT
31. FAT, CHEST BACK
32. FAT, ABDOMINAL (midpoint between nipple and umbilicus)
33. FAT, SUPRAILIAC (5 cm. above iliocristale in axillary line)
34. MID-DISTANCE FROM PORION TO OPISTHOCRANION (females only)
35. MID-DISTANCE FROM PORION TO NASION (females only)
36. MID-DISTANCE FROM PORION TO SUBNASALE (females only)
37. COSTAL ANGLE, MID-BREATH, RECLINING (females only)
38. COSTAL ANGLE AT FULL INSPIRATION, RECLINING (females only)

The results of the rotated factor loadings are tabulated in Table 22, where the factor loadings for males are tabulated at the upper left in roman type, and those of the females are underlined at the lower right. Where factor loadings are omitted, that measurement was not taken on that sex.[7]

In these studies the same four factors - fat, general growth, cross-sectional growth, and the "Factor IV" (most prominent in the chest measurements and shoulder width) - were found in both samples, details of which may be studied from the tables. As might be expected, the fat factor was more prominent in the females.

In these studies a number of measurements of lengths were included, and these are almost all heavily loaded with the general growth factor.

[7] *The anthropometric measurements were originally planned for other purposes; hence the measurements were not identical in the two studies.*

In this factor the measurements of the females are the more consistent.

There are some important differences in the cross-sectional factor loadings in the two sexes, for which we have no explanations.

Factor IV is more heavily weighted in the lengths of the clavicle and width of shoulders in the males, but more heavily weighted in the chest width and girth in the females, and this factor is also found to be heavily represented in the measurements of the costal angle in the females.

The females have another, or fifth, factor which has significant loadings only in the three head measurements. This is probably the type of growth that Scammon (2) calls "neural growth," which characterizes the growth of the brain, head, and other appendages of the skull, such as the size of the eyeballs. These measurements were not taken on the males.

DISCUSSION OF RESULTS

The results of these studies would seem to indicate that there is fairly consistent evidence that there are at least three quite different types of general bodily growth from birth to maturity, in addition to the nervous type (V) found in the adult women. The fourth factor (IV) is not as clear-cut, and will need much more confirmatory evidence before it can be clearly identified. The fact that these types do represent different kinds of growth is seen in those individuals in whom one type has been predominant. The "fat type" (I) is all too common, and this kind of growth can be superimposed on any kind of body build if glandular conditions become favorable. It may possibly be the result of a low thyroid or posterior pituitary output. The relatively pure "general growth type" (II) is seen in the very tall, long-limbed, excessively slender persons, and may possibly be due to an excessive output of thyroxin or certain hormones of the anterior pituitary. The relatively pure "cross-section type" (III) is seen in those persons having a short, very-stocky, broad-headed, short-limbed, lateral, or pyknic build. If "type IV" is a pure type of growth, it is probably seen best in those individuals who are very large chested and wide shouldered in comparison with their thickness of skeleton in general, and hips in particular. It would seem that size of the costal angle will vary with this factor. We do not wish to hazard an opinion as to what glandular or hereditary (gene) conditions might produce these latter two types of growth. Excessive growth in the "neural type" (V) is seen in those individuals with very large heads and eyes that are out of proportion to the size of the rest of the body.

It would seem that Factor III (the cross-sectional type) supplements Factor II as it were. Factor II seems to be present in a large number of measurements, in a few of which, such as height and the lengths of some of the long bones, it is found in an almost pure form; but in other measurements, as in the chest measurements, the second factor is present as well as the cross-sectional factor. This is found to be the case in the younger ages more than in the adults.

Scammon (2) has presented four types of growth: (1) general growth, (2) neural growth, (3) lymphoid growth, and (4) genital growth. In this

study no measurements have been studied that touch upon the latter two. In the last study presented (adult women), the neural type of growth has been confirmed, and in all of the studies, the "general growth" has been shown to be divisible into four subdivisions: (1) fat, (2) general, (3) cross-sectional, and (4) what we have chosen to label simply "type IV" because of the difficulties in the way of better identification. This would seem to leave us with at least seven types of growth instead of four.

It should be easily possible to study these types further, especially the first three types presented in this study, and the neural growth - and to measure them in relatively pure form. This can be done in standard score form by using the usual multiple regression formulae, and taking the factor loadings for the correlations of the variables with the dependent variable, and the usual intercorrelations for the other needed correlations. The means and standard deviations for the factors may be taken as 0 and 1, respectively. The results will be in terms of standard scores <u>of this sampling</u>. If a mean of 50 and a standard deviation of 10 are taken, the results are in terms of T-scores, which are in some cases more understandable. If this is done, the measurements correlating best with the other factors should be included to partial out the other factors, <u>if the important variables used are loaded with these other factors</u>. To hold plain size of the body constant, these factors might have to be expressed in terms of ratios with the other factors.

With relatively pure measures of these types of growth available, it seems to us that new avenues for research in various fields of anthropometry, medicine, and human biology in general may be opened up.[8]

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[8]An example of such a problem may be found in more specific studies in the field of the effect of variations in endocrine balance on physical growth. This latter type of study should be quite feasible when more accurate methods of measuring the endocrine output have been made available by the physiologists.

Introduction to Tables 1 to 22

FACTOR LOADINGS OF GROWTH FACTORS

In Tables 1 to 22 given below, the factors may be identified as follows:

Factor I - Growth in fat
Factor II - General growth
Factor III - Growth in cross-section
Factor IV - Not positively identified. Most heavily weighted with measurements of chest dimensions and width of shoulders.
Factor V - Neural growth. Found only in Table 22, females. Measurements germane to this factor were not taken in other groups.

In Tables 1 to 20, the unsmoothed, rotated factor loadings are given at the upper left, while the smoothed rotated factor loadings are underlined at the lower right. In Tables 21 and 22, the factor loadings for males are at the upper left, and the loadings for females are at the lower right and are underlined.

The symbol "h" is the square root of the sum of the squares of the four factor loadings, and is given only for the unsmoothed loadings.

TABLE 1

BOYS - AGE 9 DAYS (N = 50)

	I	II	III	IV	h
1. Weight	.772 .499	.497 .610	.325 .422	.195 .138	.993
2. Height	.583 .305	.721 .808	.029 .015	.118 .081	.955
3. Sitting height	.620 .538	.635 .751	.121 .084	-.051 .011	.896
5. Shoulder width	.644 .529	.289 .424	.363 .223	.261 .201	.835
6. Hip	.756 .445	.319 .457	.437 .388	.007 -.116	.930
9. Chest girth	.451 .540	.436 .518	.328 .379	.214 .143	.953
11. Elbow	.579 .250	.545 .372	.532 .582	.021 .009	.854
13. Knee width	.530 .587	.502 .516	.540 .499	-.117 -.058	.916
15. Arm	.844 .612	.177 .400	.406 .365	.157 .045	.965
16. Forearm	.851 .647	.188 .241	.444 .587	.102 .034	.983
17. Thigh	.801 .567	.217 .282	.367 .524	.166 .111	.923
18. Calf	.847 .524	.206 .255	.398 .566	.193 .203	.978
19. Fat chest front	.862 .829	.063 .029	.225 .073	-.098 -.091	.899
20. Fat chest back	.907 .841	-.053 -.044	.058 .015	.165 -.180	.923
21. Fat arm front	.865 .834	.010 -.063	-.077 -.121	.072 .092	.871
22. Fat arm back	.916 .833	.055 -.063	-.061 -.121	-.135 .092	.929

TABLE 2

BOYS - AGE 4 YEARS (N = 69)

	I	II	III	IV	h
1. Weight	.090 .409	.737 .666	.579 .448	.051 .110	.943
2. Height	-.057 .194	.910 .855	.101 .019	.010 .066	.918
3. Sitting height	-.041 .247	.856 .777	.026 .077	.034 .032	.858
5. Shoulder width	-.145 .232	.571 .503	.003 .194	.101 .185	.597
6. Hip width	.002 .338	.602 .539	.407 .325	-.415 -.115	.837
7. Chest width	.137 .132	.598 .511	.265 .380	-.209 .049	.700
8. Chest depth	-.119 .058	.452 .366	.557 .551	.034 .160	.728
9. Chest girth	.751 .463	.436 .521	.328 .434	.214 .185	.953
11. Elbow width	.041 .250	.312 .434	.781 .531	-.041 .023	.843
13. Knee width	.238 .321	.468 .562	.549 .422	-.088 .008	.765
15. Arm girth	.230 .560	.771 .439	.219 .413	-.094 .003	.839
16. Forearm	.385 .560	.212 .516	.827 .627	-.079 .017	.940
17. Thigh	.198 .517	.320 .323	.768 .572	.042 .067	.856
18. Calf	.036 .428	.214 .323	.849 .614	.271 .156	.918
19. Fat chest front	.786 .821	-.033 .008	-.140 -.002	-.078 -.022	.803
20. Fat chest back	.734 .828	-.136 -.006	-.019 .012	.308 .135	.808
21. Fat arm front	.808 .807	-.174 -.046	-.186 -.133	.068 .109	.850
22. Fat arm back	.746 .806	-.221 -.085	-.000 -.133	-.336 .109	.848

TABLE 3

BOYS - AGE 6 YEARS (N = 149)

	I	II	III	IV	h
1. Weight	.365 .411	.787 .706	.451 .447	.114 .090	.976
2. Height	.003 .124	.935 .902	-.023 .050	.113 .051	.942
3. Sitting height	.060 .174	.834 .823	.078 .080	.147 .044	.853
5. Shoulder width	.175 .186	.662 .577	.181 .183	.197 .188	.735
6. Hip width	.220 .267	.718 .633	.085 .257	.169 -.036	.774
7. Chest width	.053 .178	.390 .480	.590 .398	.365 .186	.797
8. Chest depth	.152 .152	.272 .329	.524 .546	.552 .215	.704
9. Chest girth	.349 .417	.441 .505	.613 .490	.436 .286	.940
11. Elbow width	.093 .179	.685 .530	.232 .444	.093 .035	.735
13. Knee width	.530 .274	.502 .633	.540 .319	-.117 .105	.916
15. Arm girth	.604 .566	.399 .429	.600 .491	-.033 -.033	.941
16. Forearm	.417 .498	.594 .416	.585 .640	.033 .011	.933
17. Thigh	.501 .529	.489 .374	.575 .576	.038 .040	.907
18. Calf	.371 .397	.624 .423	.561 .623	.053 .087	.919
19. Fat chest front	.790 .812	.042 -.017	-.050 -.059	.151 .056	.807
20. Fat chest back	.832 .828	.179 .055	-.002 .014	-.132 .063	.861
21. Fat arm front	.755 .789	-.095 -.085	-.148 -.129	.258 .124	.817
22. Fat arm back	.718 .788	.082 -.085	.143 -.129	.010 .124	.736

TABLE 4

BOYS - AGE 8 YEARS (N = 150)

	I	II	III	IV	h
1. Weight	.492 .427	.701 .693	.455 .457	.029 .033	.971
2. Height	.160 .142	.928 .932	.002 .020	-.016 .032	.942
3. Sitting height	.166 .161	.852 .837	.096 .125	-.013 .018	.874
5. Shoulder width	.240 .167	.629 .554	.274 .266	.186 .179	.750
6. Hip width	.328 .246	.657 .668	.224 .241	-.147 .021	.782
7. Chest width	.345 .223	.434 .450	.323 .435	.386 .251	.748
8. Chest depth	.315 .249	.216 .283	.602 .560	.219 .250	.746
9. Chest girth	.459 .396	.458 .482	.539 .540	.371 .319	.921
11. Elbow width	.206 .162	.563 .579	.379 .418	.080 -.000	.714
13. Knee width	.343 .294	.685 .669	.251 .297	.026 .097	.807
15. Arm girth	.612 .586	.308 .388	.640 .554	-.036 -.048	.939
16. Forearm	.498 .476	.454 .451	.657 .656	.018 .009	.941
17. Thigh	.651 .577	.513 .373	.595 .571	-.098 .026	.941
18. Calf	.463 .417	.401 .455	.666 .623	-.095 -.011	.910
19. Fat chest front	.861 .803	-.104 -.056	-.174 -.050	.026 .123	.885
20. Fat chest back	.865 .820	.093 .088	.051 .050	.057 .027	.873
21. Fat arm front	.736 .795	-.084 -.065	-.114 -.097	.046 .117	.751
22. Fat arm back	.767 .795	-.037 -.065	.169 -.097	-.149 .117	.800
10. Breathing capacity	.006 .067	.749 .719	.075 .130	.255 .172	.794

TABLE 5

BOYS - AGE 10 YEARS (N = 138)

	I	II	III	IV	h
1. Weight	.667 .456	.611 .675	.337 .441	.119 -.036	.972
2. Height	.316 .196	.914 .942	-.005 .025	.017 .035	.968
3. Sitting height	.319 .158	.849 .833	.125 .168	-.055 .012	.917
5. Shoulder width	.315 .160	.518 .497	.195 .342	.265 .199	.689
6. Hip width	.329 .260	.710 .683	.178 .248	.287 .113	.853
7. Chest width	.344 .232	.489 .468	.370 .458	.431 .251	.824
8. Chest depth	.463 .311	.362 .296	.463 .547	.340 .278	.822
9. Chest girth	.532 .393	.506 .478	.395 .558	.455 .338	.950
11. Elbow width	.206 .170	.563 .608	.379 .386	.080 -.008	.714
13. Knee width	.402 .256	.695 .684	.313 .304	.199 .071	.884
15. Arm girth	.751 .624	.333 .353	.494 .575	-.036 -.018	.959
16. Forearm	.617 .471	.438 .484	.594 .648	.024 .008	.962
17. Thigh	.755 .635	.416 .386	.367 .520	.188 .051	.955
18. Calf	.615 .467	.500 .493	.493 .561	.076 -.022	.936
19. Fat chest front	.784 .799	-.070 -.068	.027 .005	.250 .174	.826
20. Fat chest back	.851 .815	.076 .118	.032 .096	.074 .020	.858
21. Fat arm front	.885 .831	.027 -.034	-.042 -.067	.037 .114	.887
22. Fat arm back	.861 .831	.218 -.034	-.064 -.067	-.141 .114	.902
10. Breathing capacity	.199 .054	.657 .731	.109 .178	.062 .137	.698

TABLE 6

BOYS - AGE 12 YEARS (N = 129)

	I	II	III	IV	
1. Weight	.214 .380	.603 .687	.634 .471	-.306 -.036	.9
2. Height	.213 .178	.997 .956	.126 .045	.068 .027	1.030
3. Sitting height	.033 .096	.757 .831	.409 .192	-.022 .031	.862
5. Shoulder width	-.047 .108	.170 .458	.819 .424	.025 .149	.838
6. Hip width	.129 .221	.582 .679	.562 .291	.132 .066	.840
7. Chest width	.042 .203	.391 .511	.763 .485	-.281 .164	.903
8. Chest depth	.185 .289	.188 .326	.702 .533	.174 .279	1.158
9. Chest girth	.171 .326	.386 .495	.839 .605	.044 .295	.940
11. Elbow width	.095 .134	.591 .607	.492 .369	-.256 -.026	.817
13. Knee width	.524 .258	.643 .670	.467 .343	-.171 -.034	.875
15. Arm girth	.494 .557	.333 .376	.660 .588	-.095 .014	.894
16. Forearm	.352 .385	.421 .509	.751 .676	-.010 -.021	.923
17. Thigh	.530 .597	.289 .385	.699 .551	-.210 .047	.947
18. Calf	.356 .427	.428 .490	.653 .547	-.254 -.018	.895
19. Fat chest front	.715 .796	-.106 -.054	.262 .045	.308 .149	.828
20. Fat chest back	.693 .792	.143 .126	.261 .140	-.116 .040	.763
21. Fat arm front	.858 .851	-.022 -.049	.035 -.053	.259 .107	.897
22. Fat arm back	.874 .851	-.034 -.049	-.030 -.053	-.055 .107	.877
10. Breathing capacity	-.020 .029	.760 .761	.463 .243	.091 .119	.894

TABLE 7

BOYS - AGE 14 YEARS (N = 141)

	I	II	III	IV	h
1. Weight	.314 .351	.848 .700	.347 .485	.154 .007	.981
2. Height	.060 .119	.949 .947	.010 .038	.023 .031	.951
3. Sitting height	.008 .096	.894 .831	.053 .192	.196 .031	.916
5. Shoulder width	-.063 .076	.657 .498	.124 .377	.290 .160	.732
6. Hip width	.216 .207	.818 .685	.041 .253	.020 .007	.847
7. Chest width	.232 .206	.703 .546	.249 .454	.397 .248	.876
8. Chest depth	.255 .292	.511 .357	.403 .475	.342 .293	.778
9. Chest girth	.329 .326	.655 .495	.467 .605	.412 .295	.962
11. Elbow width	.052 .117	.603 .602	.166 .316	.389 .027	.738
13. Knee width	.294 .227	.685 .572	.220 .331	-.061 -.041	.779
15. Arm girth	.552 .506	.498 .364	.489 .604	.273 .080	.931
16. Forearm	.311 .313	.699 .527	.665 .689	-.050 -.030	1.015
17. Thigh	.591 .572	.530 .384	.420 .553	.230 .083	.927
18. Calf	.350 .390	.657 .469	.369 .518	.220 .061	.859
19. Fat chest front	.897 .814	-.026 -.027	-.157 .040	.003 .072	.911
20. Fat chest back	.842 .795	.178 .101	.050 .148	.209 .069	.887
21. Fat arm front	.883 .854	-.078 -.081	-.169 -.070	.050 .074	.904
22. Fat arm back	.811 .854	-.092 -.081	.084 .070	-.185 .073	.841
10. Breathing capacity	-.092 .011	.848 .743	.128 .263	.101 .138	.868

TABLE 8

BOYS - AGE 16 YEARS (N = 107)

	I	II	III	IV	h
1. Weight	.313 .361	.759 .651	.512 .552	.025 .023	.968
2. Height	.063 .065	.958 .925	.014 .032	.001 .032	.960
3. Sitting height	-.058 .000	.866 .758	.047 .104	.075 .067	.872
5. Shoulder width	.151 .100	.635 .505	.452 .365	-.117 .161	.802
6. Hip width	.181 .211	.646 .644	.270 .265	-.268 -.079	.772
7. Chest width	.200 .235	.607 .509	.511 .451	.276 .356	.864
8. Chest depth	.296 .322	.418 .312	.360 .447	.407 .268	.747
9. Chest girth	.236 .332	.520 .413	.661 .608	.416 .386	.967
11. Elbow width	.089 .141	.673 .577	.248 .316	-.192 .078	.748
13. Knee width	.264 .268	.656 .523	.370 .335	-.159 -.015	.813
15. Arm girth	.317 .458	.414 .271	.709 .665	-.032 .103	.881
16. Forearm	.117 .268	.592 .460	.660 .717	-.123 -.013	.903
17. Thigh	.444 .562	.395 .309	.696 .589	.072 .093	.918
18. Calf	.385 .367	.410 .354	.577 .547	.102 .095	.812
19. Fat chest front	.800 .818	.126 -.021	.052 .071	-.111 -.003	.819
20. Fat chest back	.799 .796	.104 .026	.163 .163	.086 .055	.826
21. Fat arm front	.807 .833	-.187 -.116	-.045 -.068	-.036 .038	.831
22. Fat arm back	.819 .833	-.050 -.116	.063 -.068	-.135 .038	.846
10. Breathing capacity	.103 .015	.803 .660	.250 .312	.220 .191	.880

TABLE 9

BOYS - COLLEGE AGE (N = 336)

	I	II	III	IV	h
1. Weight	.489 .411	.430 .586	.701 .598	.043 .049	.958
2. Height	.019 .039	.852 .898	.033 .024	.056 .034	.855
3. Sitting height	.042 .005	.561 .700	.089 .073	.004 .049	.570
5. Shoulder width	.134 .118	.385 .499	.287 .324	.398 .214	.638
6. Hip width	.264 .231	.546 .610	.309 .266	-.014 -.095	.681
7. Chest width	.331 .276	.320 .458	.421 .432	.619 .480	.879
8. Chest depth	.438 .371	.117 .261	.479 .431	.112 .236	.669
9. Chest girth	.484 .384	.154 .332	.571 .590	.451 .435	.888
11. Elbow width	.268 .184	.459 .546	.426 .338	.038 .000	.682
13. Knee width	.235 .251	.245 .480	.332 .332	.211 .057	.519
15. Arm girth	.524 .458	-.045 .169	.739 .701	.191 .126	.927
16. Forearm	.370 .279	.182 .376	.800 .737	.120 .020	.908
17. Thigh	.671 .586	.083 .237	.560 .590	.124 .119	.886
18. Calf	.364 .370	.073 .250	.601 .567	.121 .126	.717
19. Fat chest front	.819 .821	-.138 -.037	.178 .099	-.003 -.038	.849
20. Fat chest back	.796 .802	-.191 -.052	.205 .174	-.022 .040	.844
21. Fat arm front	.817 .821	-.100 -.127	-.059 -.067	.032 .011	.826
22. Fat arm back	.704 .821	-.173 -.127	-.120 -.067	-.009 .011	.735
10. Breathing capacity	.009 .029	.354 .560	.448 .346	.254 .226	.625

TABLE 10

GIRLS - AGE 9 DAYS (N = 50)

	I	II	III	IV	h
1. Weight	.520 .464	.685 .707	.393 .387	.271 .293	.984
2. Height	.295 .207	.905 .918	-.003 -.030	.016 .015	.952
3. Sitting height	.277 .167	.852 .883	.236 .180	.007 .044	.927
5. Shoulder width	.179 .186	.302 .436	.603 .414	.204 .287	.727
6. Hip width	.289 .295	.268 .428	.574 .374	.022 .253	.697
9. Chest girth	.507 .493	.466 .445	.400 .454	.419 .384	.899
11. Elbow width	.300 .253	.411 .481	.486 .507	.163 .075	.722
13. Knee width	.212 .303	.342 .467	.599 .415	-.012 .127	.722
15. Arm girth	.604 .551	.303 .280	.642 .656	.226 .165	.959
16. Forearm	.484 .479	.423 .426	.656 .651	.183 .155	.937
17. Thigh	.637 .587	.317 .397	.546 .527	-.008 .134	.897
18. Calf	.671 .513	.295 .418	.539 .560	.273 .191	.950
19. Fat chest front	.689 .732	.134 .042	.268 .095	-.111 .034	.759
20. Fat chest back	.754 .779	.070 .078	.244 .138	-.230 -.108	.828
21. Fat arm front	.747 .743	-.009 .041	-.252 -.166	.252 .156	.827
22. Fat arm back	.707 .639	-.041 .029	.104 .172	.286 .133	.771

TABLE 11

GIRLS - AGE 4 YEARS (N = 70)

	I	II	III	IV	h
1. Weight	.410 .504	.738 .704	.345 .408	.373 .260	.985
2. Height	.084 .182	.933 .922	-.093 -.033	.018 .035	.941
3. Sitting height	-.014 .158	.928 .893	.120 .140	.127 .056	.944
5. Shoulder width	.144 .224	.627 .487	.162 .306	.407 .281	.778
6. Hip width	.507 .295	.608 .428	.115 .374	.509 .253	.858
7. Chest width	.128 .203	.445 .499	.577 .463	.470 .483	.876
8. Chest depth	.344 .312	.126 .227	.612 .491	.236 .320	.751
9. Chest girth	.505 .495	.347 .455	.564 .451	.445 .321	.944
11. Elbow width	.210 .269	.584 .489	.570 .465	-.395 .075	.848
13. Knee width	.441 .350	.621 .518	.190 .314	.307 .168	.843
15. Arm girth	.478 .557	.218 .287	.661 .643	.087 .126	.849
16. Forearm	.482 .504	.427 .418	.687 .603	.085 .156	.945
17. Thigh	.527 .585	.398 .370	.514 .506	.397 .152	.922
18. Calf	.276 .472	.567 .475	.609 .557	.071 .149	.880
19. Fat chest front	.763 .768	-.116 .037	-.186 .009	.151 .053	.808
20. Fat chest back	.815 .789	.097 .075	-.009 .149	.054 -.035	.822
21. Fat arm front	.722 .738	.093 .063	.004 -.165	.010 .118	.728
22. Fat arm back	.452 .659	-.017 .040	.292 .185	-.087 .086	.546

TABLE 12

GIRLS - AGE 6 YEARS (N = 110)

	I	II	III	IV	h
1. Weight	.343 .503	.720 .694	.482 .436	.159 .192	.945
2. Height	.141 .157	.940 .925	.021 -.030	-.002 .067	.951
3. Sitting height	.155 .148	.898 .894	.082 .099	-.018 .048	.915
5. Shoulder width	.347 .274	.537 .546	.225 .187	.346 .239	.761
6. Hip width	.287 .331	.684 .600	.144 .206	.641 .411	.991
7. Chest width	.245 .263	.600 .517	.310 .430	.533 .447	.895
8. Chest depth	.190 .347	.367 .271	.321 .459	.487 .316	.714
9. Chest girth	.391 .504	.633 .480	.397 .445	.025 .230	.844
11. Elbow width	.145 .262	.520 .501	.419 .396	.144 .056	.698
13. Knee width	.348 .376	.629 .576	.173 .228	.278 .227	.790
15. Arm girth	.501 .584	.350 .292	.717 .623	.094 .081	.947
16. Forearm	.442 .539	.440 .394	.516 .553	.226 .128	.840
17. Thigh	.518 .601	.555 .410	.472 .476	.084 .118	.897
18. Calf	.429 .455	.589 .514	.521 .545	.139 .081	.907
19. Fat chest front	.852 .825	.055 .024	.075 -.050	.124 .047	.866
20. Fat chest back	.795 .807	.055 .049	.247 .160	.018 .025	.835
21. Fat arm front	.792 .742	.140 .074	-.252 -.161	.118 .062	.851
22. Fat arm back	.861 .713	.120 .054	.156 .175	.031 .059	.883

TABLE 13

GIRLS - AGE 8 YEARS (N = 102)

	I	II	III	IV	h
1. Weight	.540 .542	.628 .671	.494 .456	.088 .121	.968
2. Height	.221 .144	.903 .919	-.057 -.013	.196 .134	.952
3. Sitting height	.317 .154	.897 .887	.027 .070	-.027 .051	.952
5. Shoulder width	.349 .292	.519 .587	.009 .116	.005 .136	.625
6. Hip width	.434 .355	.536 .654	.180 .185	.340 .342	.790
7. Chest width	.456 .317	.464 .534	.353 .421	.402 .396	.842
8. Chest depth	.524 .414	.315 .303	.399 .442	.238 .302	.767
9. Chest girth	.641 .527	.391 .462	.372 .458	.249 .230	.874
10. Breathing capacity	.055 .030	.623 .630	.307 .305	.199 .053	.732
11. Elbow width	.602 .276	.379 .498	.182 .339	.188 .032	.758
13. Knee width	.498 .395	.515 .576	.108 .213	.068 .234	.727
15. Arm girth	.764 .640	.320 .292	.442 .587	.004 .041	.939
16. Forearm	.749 .576	.329 .345	.368 .600	.148 .005	.909
17. Thigh	.738 .641	.436 .415	.431 .460	.061 .073	.961
18. Calf	.552 .470	.510 .506	.526 .548	.033 .011	.918
19. Fat chest front	.853 .868	-.046 .021	-.318 -.101	-.033 .042	.912
20. Fat chest back	.799 .829	.058 .040	.238 .169	.177 .048	.854
21. Fat arm front	.656 .725	.031 .051	-.236 -.124	.036 .027	.698
22. Fat arm back	.729 .726	.093 .064	.166 .162	.113 .041	.762

TABLE 14

GIRLS - AGE 10 YEARS (N = 124)

	I	II	III	IV	h
1. Weight	.555 .532	.666 .653	.405 .458	.056 .071	.959
2. Height	.085 .133	.931 .914	-.036 -.000	.166 .150	.950
3. Sitting height	.118 .141	.852 .869	.015 .068	.111 .024	.867
5. Shoulder width	.260 .282	.706 .605	.059 .149	.083 .092	.759
6. Hip width	.345 .360	.790 .703	.254 .209	.054 .212	.900
7. Chest width	.332 .326	.595 .556	.500 .443	.214 .360	.872
8. Chest depth	.474 .466	.328 .320	.538 .449	.195 .268	.813
9. Chest girth	.561 .525	.483 .448	.539 .476	.186 .275	.935
10. Breathing capacity	.002 .099	.619 .651	.519 .278	-.277 .059	.749
11. Elbow width	.187 .224	.495 .494	.398 .366	-.203 .003	.692
13. Knee width	.251 .385	.680 .538	.337 .288	.468 .226	.926
15. Arm girth	.664 .653	.251 .287	.612 .572	.036 .027	.937
16. Forearm	.578 .576	.294 .345	.665 .600	-.172 .005	.945
17. Thigh	.688 .661	.395 .454	.436 .456	-.081 .018	.909
18. Calf	.484 .498	.409 .462	.532 .561	-.168 -.037	.844
19. Fat chest front	.951 .891	.025 .020	.066 -.060	.025 .030	.954
20. Fat chest back	.895 .854	-.101 .036	.111 .167	-.077 .026	.911
21. Fat arm front	.801 .710	.006 .032	.021 -.074	-.139 .026	.81
22. Fat arm back	.769 .733	.015 .043	.087 .135	.015 .016	.7[illegible]

TABLE 15

GIRLS - AGE 12 YEARS (N = 151)

	I	II	III	IV	h
1. Weight	.533 .565	.649 .605	.499 .481	.137 .091	.986
2. Height	.100 .123	.888 .893	.007 .010	.267 .141	.932
3. Sitting height	.172 .134	.864 .844	.028 .085	.059 .018	.884
5. Shoulder width	.227 .292	.618 .563	.283 .186	-.050 .120	.718
6. Hip width	.324 .351	.719 .700	.219 .244	.159 .134	.834
7. Chest width	.201 .304	.584 .515	.529 .458	.392 .406	.903
8. Chest depth	.480 .494	.271 .302	.455 .456	.404 .262	.821
9. Chest girth	.410 .498	.404 .385	.571 .473	.454 .400	.929
10. Breathing capacity	-.017 .054	.697 .630	.250 .241	.319 .149	.807
11. Elbow width	.179 .224	.488 .471	.464 .434	.086 .044	.702
13. Knee width	.420 .415	.398 .460	.379 .368	.100 .139	.699
15. Arm girth	.663 .642	.250 .257	.639 .561	.010 .051	.954
16. Forearm	.472 .549	.396 .319	.727 .657	.008 .020	.953
17. Thigh	.619 .647	.489 .430	.520 .495	.079 .038	.948
18. Calf	.470 .498	.464 .402	.636 .607	.018 -.032	.917
19. Fat chest front	.885 .874	.073 .026	-.054 -.039	.228 .086	.918
20. Fat chest back	.866 .873	.178 .074	.219 .183	-.037 .048	.911
21. Fat arm front	.650 .673	-.019 .038	.053 -.007	.164 .050	.673
22. Fat arm back	.638 .695	.044 .025	.187 .142	-.153 -.043	.684

TABLE 16

GIRLS - AGE 13 YEARS (N = 164)

	I	II	III	IV	h
1. Weight	.633 .591	.605 .530	.438 .518	.090 .129	.983
2. Height	.164 .102	.915 .867	.013 .004	-.075 .078	.932
3. Sitting height	.130 .110	.840 .803	.066 .126	-.166 .026	.873
5. Shoulder width	.260 .256	.499 .491	.353 .186	.325 .202	.739
6. Hip width	.405 .327	.762 .669	.179 .292	.104 .115	.888
7. Chest width	.378 .307	.523 .456	.413 .426	.475 .469	.902
8. Chest depth	.576 .486	.358 .273	.396 .430	.053 .283	.787
9. Chest girth	.551 .484	.355 .359	.386 .399	.489 .485	.904
10. Breathing capacity	.159 .120	.735 .603	.124 .186	.138 .193	.775
11. Elbow width	.304 .222	.539 .440	.628 .484	.168 .137	.793
13. Knee width	.531 .421	.345 .380	.429 .461	.012 .061	.765
15. Arm girth	.659 .620	.279 .213	.583 .555	.137 .126	.933
16. Forearm	.567 .526	.334 .274	.699 .671	.022 .107	.960
17. Thigh	.654 .632	.498 .387	.422 .539	.042 .063	.925
18. Calf	.559 .497	.397 .320	.609 .644	-.036 .007	.918
19. Fat chest front	.840 .847	-.006 .024	-.067 .011	.076 .099	.846
20. Fat chest back	.874 .878	.100 .081	.130 .185	.165 .073	.904
21. Fat arm front	.580 .660	.108 .046	-.112 -.007	.137 .047	.61[illegible]
22. Fat arm back	.691 .689	-.053 .008	.097 .137	-.121 -.045	.70[illegible]

TABLE 17

GIRLS - AGE 15 YEARS (N = 136)

	I	II	III	IV	h
1. Weight	.574 .600	.325 .427	.654 .567	.258 .210	.965
2. Height	.088 .074	.780 .834	.003 -.001	.086 .082	.789
3. Sitting height	.041 .099	.723 .759	.280 .168	.118 .085	.785
5. Shoulder width	.257 .266	.285 .388	-.007 .112	.414 .254	.564
6. Hip width	.249 .290	.496 .581	.495 .346	.073 .167	.747
7. Chest width	.260 .308	.187 .359	.351 .397	.699 .535	.845
8. Chest depth	.382 .420	.215 .202	.474 .419	.413 .367	.766
9. Chest girth	.386 .448	.180 .240	.323 .324	.642 .566	.835
10. Breathing capacity	.157 .144	.251 .548	.231 .157	.470 .264	.602
11. Elbow width	.264 .231	.485 .435	.440 .466	.171 .218	.726
13. Knee width	.416 .408	.384 .320	.532 .525	-.079 -.012	.781
15. Arm girth	.635 .640	.055 .131	.604 -.534	.326 .229	.936
16. Forearm	.484 .496	.099 .202	.640 .639	.310 .208	.866
17. Thigh	.542 .628	.181 .236	.749 .600	.126 .118	.950
18. Calf	.434 .467	.106 .228	.749 .682	.067 .067	.874
19. Fat chest front	.782 .812	.022 .016	.127 .026	.220 .110	.822
20. Fat chest back	.926 .863	.073 .057	.270 .177	.190 .116	.986
21. Fat arm front	.690 .660	.159 .046	-.002 -.007	-.038 .047	.707
22. Fat arm back	.690 .686	.080 -.017	.184 .139	.012 .001	.719

TABLE 18

GIRLS - AGE 16 YEARS (N = 113)

	I	II	III	IV	h
1. Weight	.656 .589	.338 .388	.637 .590	.162 .243	.988
2. Height	-.034 .037	.797 .830	.009 -.005	.058 .093	.800
3. Sitting height	.042 .074	.682 .732	.204 .175	.270 .126	.762
5. Shoulder width	.296 .262	.414 .354	.005 .084	.030 .258	.510
6. Hip width	.237 .239	.516 .521	.409 .350	.206 .201	.730
7. Chest width	.370 .325	.400 .325	.331 .401	.403 .510	.754
8. Chest depth	.445 .354	.084 .148	.284 .418	.559 .422	.773
9. Chest girth	.553 .426	.208 .199	.110 .306	.517 .583	.792
10. Breathing capacity	.322 .140	.707 .549	.056 .149	.027 .235	.780
11. Elbow width	.197 .201	.381 .422	.351 .447	.490 .243	.740
13. Knee width	.272 .365	.139 .297	.702 .571	.003 -.029	.765
15. Arm girth	.728 .649	.026 .090	.408 .530	.386 .271	.920
16. Forearm	.542 .454	.178 .171	.539 .632	.432 .226	.895
17. Thigh	.718 .631	.076 .145	.614 .620	.109 .145	.954
18. Calf	.504 .432	.136 .194	.666 .687	.164 .083	.862
19. Fat chest front	.820 .777	.020 .004	.089 .024	-.059 .065	.827
20. Fat chest back	.805 .834	.025 .016	.183 .139	-.072 .121	.829
21. Fat arm front	.721 .698	-.179 -.010	-.053 -.037	-.066 -.065	.748
22. Fat arm back	.706 .699	-.030 -.052	.112 .115	.181 .052	.738

TABLE 19

GIRLS - AGE 17 YEARS (N = 97)

	I	II	III	IV	h
1. Weight	.570 .536	.335 .409	.493 .601	.475 .272	.952
2. Height	.038 .020	.857 .846	-.069 -.004	.250 .129	.896
3. Sitting height	.152 .056	.755 .733	.108 .154	.147 .106	.792
5. Shoulder width	.288 .231	.197 .350	.028 .124	.382 .284	.518
6. Hip width	.257 .273	.468 .477	.234 .319	.502 .200	.763
7. Chest width	.296 .317	.237 .306	.505 .444	.567 .481	.849
8. Chest depth	.114 .273	.118 .123	.533 .461	.438 .438	.709
9. Chest girth	.257 .365	.083 .188	.387 .394	.702 .592	.846
10. Breathing capacity	-.022 .060	.591 .536	.138 .196	.321 .235	.688
11. Elbow width	.111 .165	.530 .412	.456 .462	.042 .182	.709
13. Knee width	.402 .342	.362 .334	.484 .567	.001 -.051	.726
15. Arm girth	.681 .625	.024 .095	.479 .566	.273 .237	.877
16. Forearm	.325 .373	.103 .175	.627 .679	.024 .154	.714
17. Thigh girth	.665 .592	-.053 .126	.562 .637	.306 .163	.924
18. Calf girth	.306 .374	.202 .218	.707 .689	.123 .068	.806
19. Fat chest front	.760 .725	-.024 .007	-.140 .001	.068 .072	.777
20. Fat chest back	.762 .816	-.131 .001	-.061 .102	.325 .151	.841
21. Fat arm front	.692 .727	-.041 -.003	-.011 -.028	-.208 -.100	.724
22. Fat arm back	.674 .711	-.270 -.063	.096 .068	.083 -.007	.737

TABLE 20

GIRLS - COLLEGE AGE (N = 306)

	I	II	III	IV	h
1. Weight	.410 .491	.557 .465	.667 .606	.147 .258	.972
2. Height	.015 .017	.889 .868	.049 .005	.070 .128	.894
3. Sitting height	-.024 .042	.748 .743	.126 .128	.038 .051	.760
5. Shoulder width	.123 .197	.483 .380	.343 .200	.313 .305	.681
6. Hip width	.321 .290	.435 .466	.285 .281	-.064 .155	.614
7. Chest width	.321 .318	.352 .319	.489 .477	.376 .441	.779
8. Chest depth	.282 .244	.155 .135	.503 .489	.368 .412	.702
9. Chest girth	.340 .336	.275 .206	.613 .482	.516 .578	.913
10. Breathing capacity	-.033 .031	.396 .539	.337 .239	.309 .249	.606
11. Elbow width	.165 .150	.291 .381	.549 .496	.120 .135	.654
13. Knee width	.304 .333	.418 .369	.573 .558	-.130 -.071	.782
15. Arm girth	.497 .584	.226 .114	.746 .620	.073 .174	.928
16. Forearm	.273 .320	.271 .205	.837 .734	.045 .081	.922
17. Thigh girth	.453 .553	.321 .169	.697 .639	.070 .153	.894
18. Calf girth	.336 .345	.326 .264	.666 .680	-.093 .036	.820
19. Fat chest front	.606 .681	-.018 -.016	.042 -.013	.114 .060	.619
20. Fat chest back	.840 .806	.086 .007	.154 .086	.112 .162	.865
21. Fat arm front	.780 .744	.099 -.034	-.036 -.029	.055 -.096	.788
22. Fat arm back	.757 .724	.055 -.063	.043 .068	-.098 - -.007	.766

TABLE 21

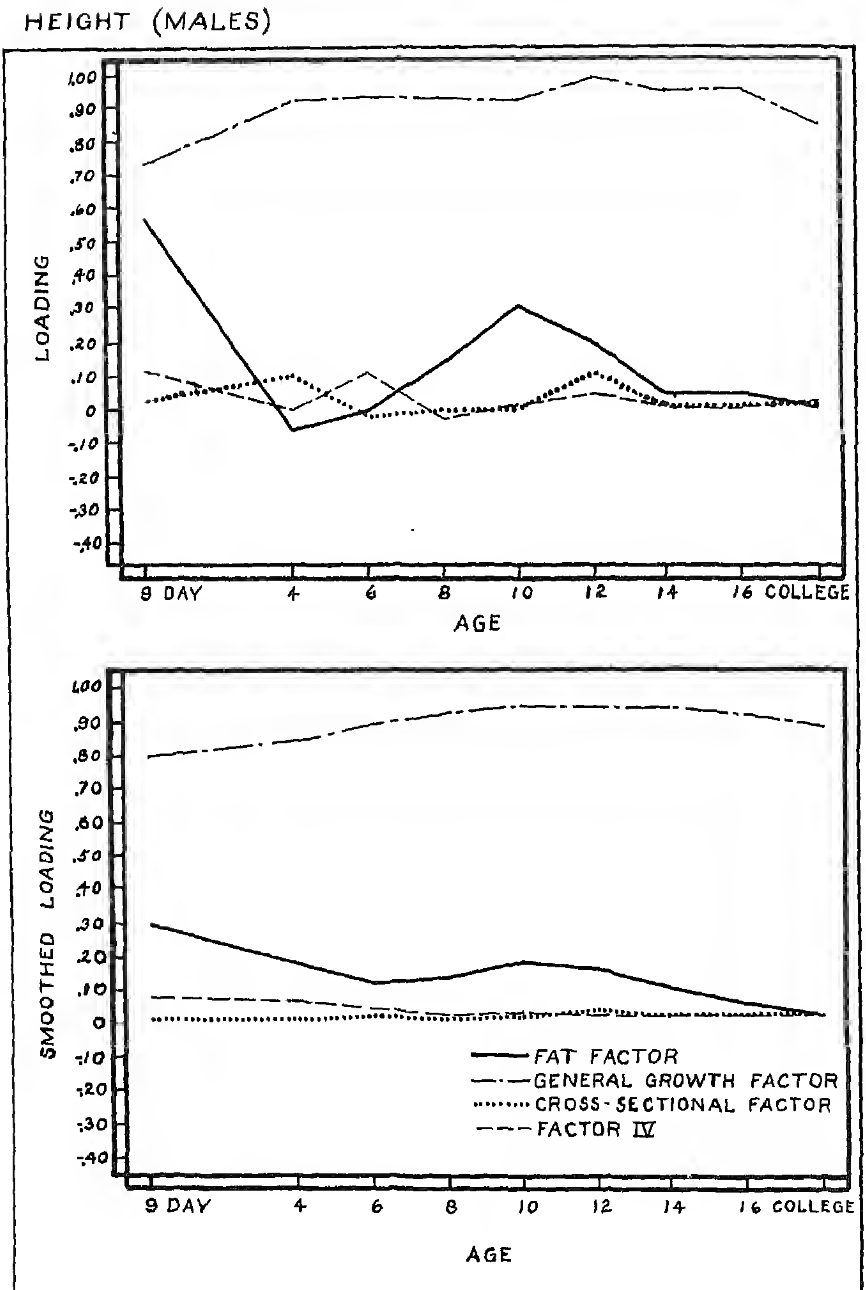
FACTOR LOADINGS FOR BOYS (N = 32,165) AND GIRLS (N = 31,919) FROM THE BUREAU OF HOME ECONOMICS GARMENT STUDY. BOYS' FACTOR LOADINGS ARE IN ROMAN TYPE AT THE UPPER LEFT, AND GIRLS' FACTOR LOADINGS ARE UNDERLINED AT THE LOWER RIGHT

	II (General Growth Facta)	III (Cross Sectional Facta)	h
1. Height	.996	.036	.997
	.997	.044	.998
2. Height cervicale	.997	.033	.997
	.997	.047	.998
3. Height waist	.997	.012	.997
	.996	.038	.997
4. Height hips	.994	-.019	.994
	.990	-.000	.990
5. Height tibiale	.982	.001	.982
	.977	.019	.977
6. Length left arm posterior	.981	.042	.982
	.980	.061	.982
7. Crotch length	.893	.307	.944
	.884	.341	.947
8. Girth trunk vertically	.926	.295	.972
	.933	.280	.974
9. Weight	.997	.012	.997
	.893	.429	.991
10. Hip width, bitrochanteric	.907	.345	.971
	.897	.375	.972
11. Girth neck base	.848	.300	.899
	.849	.302	.901
12. Girth chest scye	.885	.390	.967
	.862	.444	.969
13. Girth waist	.776	.505	.926
	.727	.563	.920
14. Girth hips	.890	.431	.989
	.880	.453	.990
15. Girth arm scye	.892	.342	.956
	.885	.392	.969
16. Girth upper arm	.763	.569	.952
	.730	.611	.952
17. Girth thigh	.816	.520	.967
	.805	.557	.979
18. Girth knee (tibiale)	.902	.334	.962
	.879	.391	.962
19. Girth calf	.863	.419	.959
	.840	.459	.196

TABLE 22

FACTOR LOADINGS OF GROWTH FACTORS OF COLLEGE MEN (N = 200) AND COLLEGE WOMEN (N = 700). LOADINGS FOR MEN ARE IN ROMAN TYPE AT UPPER LEFT, AND LOADINGS FOR WOMEN ARE UNDERLINED AT LOWER RIGHT

	I	II	III	IV	V	h
1. Weight	.658	.418	.570	.140		.976
	.709	.347	.517	.246	.142	.985
2. Height	.070	.851	.132	.085		.868
	-.039	.990	.057	.093	.290	1.038
3. Sitting height	.159	.770	.359	-.013	-	.867
4. Sitting height to cervicle	.130	.803	-.073	.091	.070	.825
5. L. cervicle to lumbale	-.001	.251	.170	.236		.384
	-.104	.480	.443	-.149	-.074	.682
6. L. sternum	.298	.315	.405	.103		.602
	.222	.352	.216	-.158	-.191	.530
7. L. upper arm	.108	.670	.099	.066		.689
	.264	.774	.125	-.216	.017	.855
8. L. forearm	.033	.261	.046	-.095		.283
	.127	.635	.003	-.020	.365	.744
9. L. head	.000	.257	.100	-.051		.281
	.057	.675	.254	.010	.186	.747
10. L. tibia	.075	.667	-.008	.002		.671
	.151	.825	-.056	-.208	.041	.867
11. L. foot	.150	.767	.231	-.009		.815
	.154	.648	.281	.148	.172	.758
12. L. clavicle	-.005	.323	.145	.655		.742
	.116	.611	.229	.086	-.131	.681
13. L. clavicle including acromion	.180	.354	.275	.650		.810
	.209	.663	.325	.111	-.161	.800
14. L. 10th rib	.340	.237	.402	.022		.577
	.520	.582	.230	-.199	-.164	.736
15. W. shoulders	.180	.288	.358	.381		.624
	.250	.516	.240	.336	-.068	.710
16. W. hips iliocristale	.419	.467	.457	-.137		.768
	.212	.093	.221	.056	.071	.333
17. W. hips iliospinale anterior	.420	.398	.261	-.168		.656
	.244	.352	.041	.008	.002	.430
18. W. ilium top	.435	.364	.079	.046		.574
	.460	.399	.282	.306	.259	.781
19. W. elbow	.222	.485	.480	-.061		.719
	.494	.288	.457	.003	-.087	.737
20. W. knee	.178	.350	.083	.002		.401
	.464	.239	.581	.133	-.028	.795
21. D. chest	.615	.191	.411	.137		.776
	.726	.199	.231	.074	.196	.815
22. W. chest	.464	.283	.571	.034		.789
	.523	.237	.266	.510	.125	.822
23. G. chest	.594	.270	.620	.061		.902
	.730	.265	.219	.318	.154	.881
24. G. neck	.363	.255	.600	.087		.741
	.624	.135	.252	.146	.104	.709
25. G. arm	.611	.122	.665	.070		.914
	.776	-.025	.446	.240	.038	.928
26. G. forearm	.406	.335	.680	.106		.866
	.653	.169	.575	.214	.047	.916
27. G. thigh	.726	.237	.392	.162		.875
	.670	.124	.519	.167	.119	.881
28. G. calf	.427	.321	.443	.093		.700
	.581	-.076	.675	.116	-.088	.905
29. Breathing capacity	.134	.394	.501	.106		.660
	.187	.511	.301	.231	.078	.668
30. Fat chest front	.914	.023	-.071	-.069		.920
	.874	.059	-.052	.056	-.178	.897
31. Fat chest back	.882	.006	.092	.039		.888
	.825	.015	.051	-.077	-.242	.865
32. Fat abdomen	.909	-.001	-.017	-.030		.910
	.860	.052	-.068	.201	-.060	.889
33. Fat suprailiac	.888	.001	-.081	.038		.893
	.780	.019	-.011	.048	-.117	.790
34. Porion-opisthocranion	-.016	.044	-.100	.059	.680	.681
35. Porion-nasion	.188	.131	.090	-.037	.757	.797
36. Porion-subnasale	.206	.094	-.006	.128	.829	.869
37. Costal angle, mid-respiration	.164	-.249	-.007	.608	.416	.795
38. Costal angle, inspiration	.089	-.258	.087	.572	.379	.750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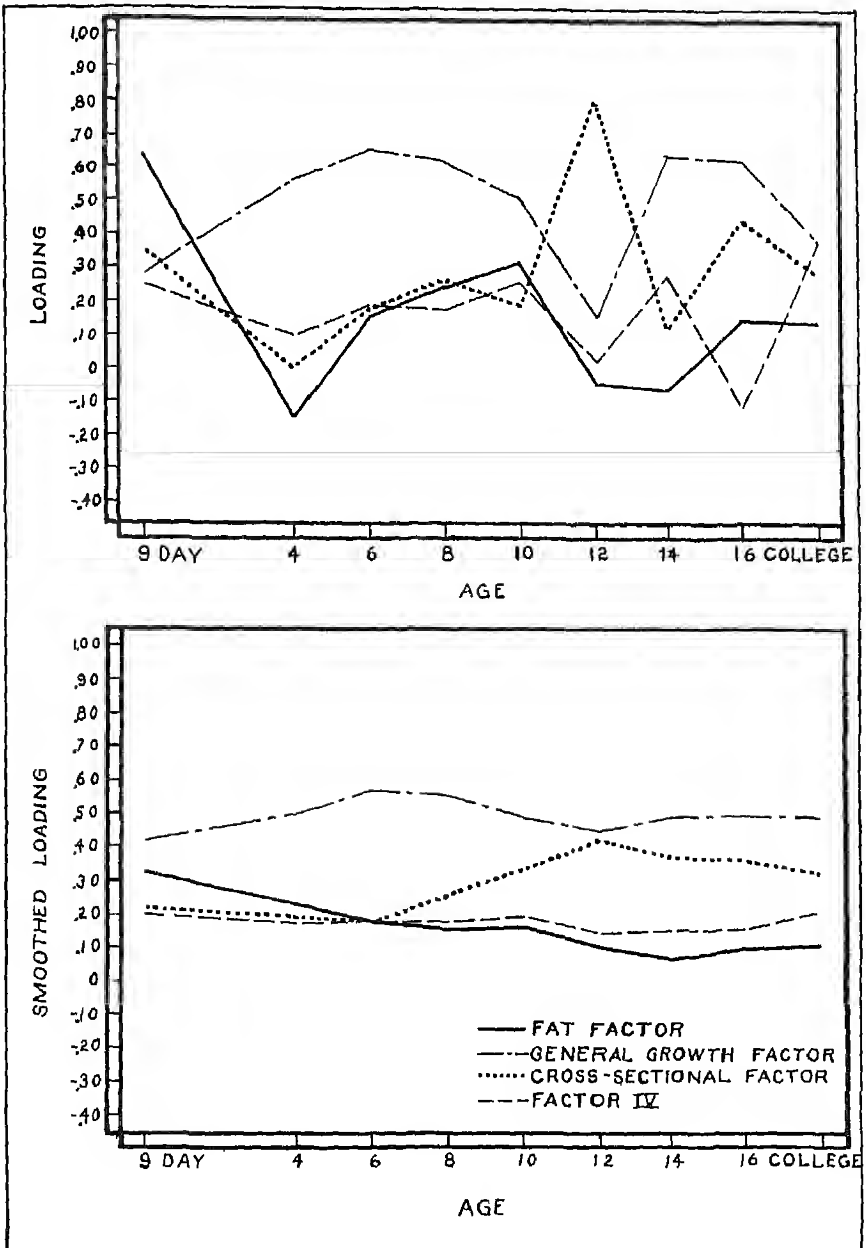
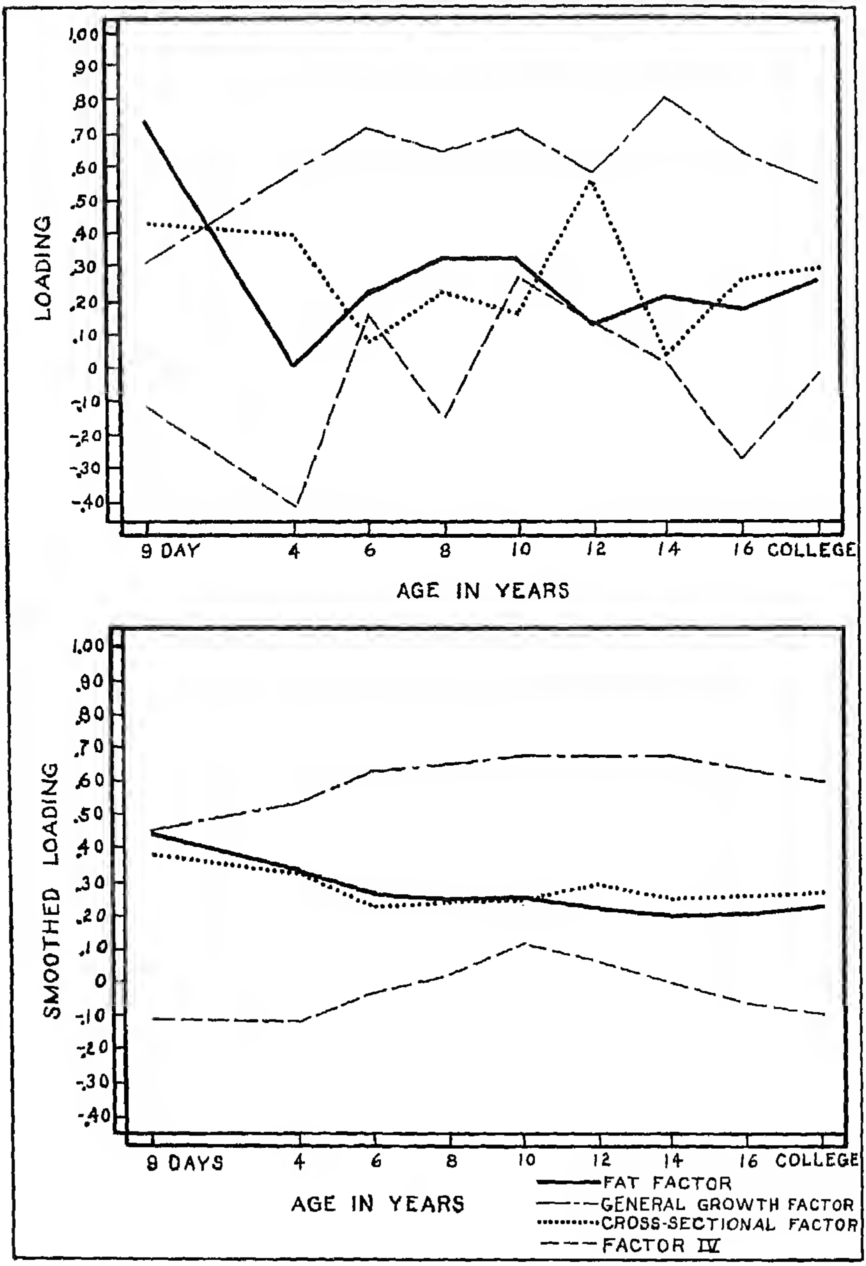
.80
.70
.60
.50
.40
.30
.20
.10
0
-.10
-.20
-.30
-.40
9 DAY
4
6
8
10
12
14
16 COLLEGE
AGE
SMOOTHED LOADING
FAT FACTOR
GENERAL GROWTH FACTOR
CROSS-SECTIONAL FACTOR
FACTOR IV

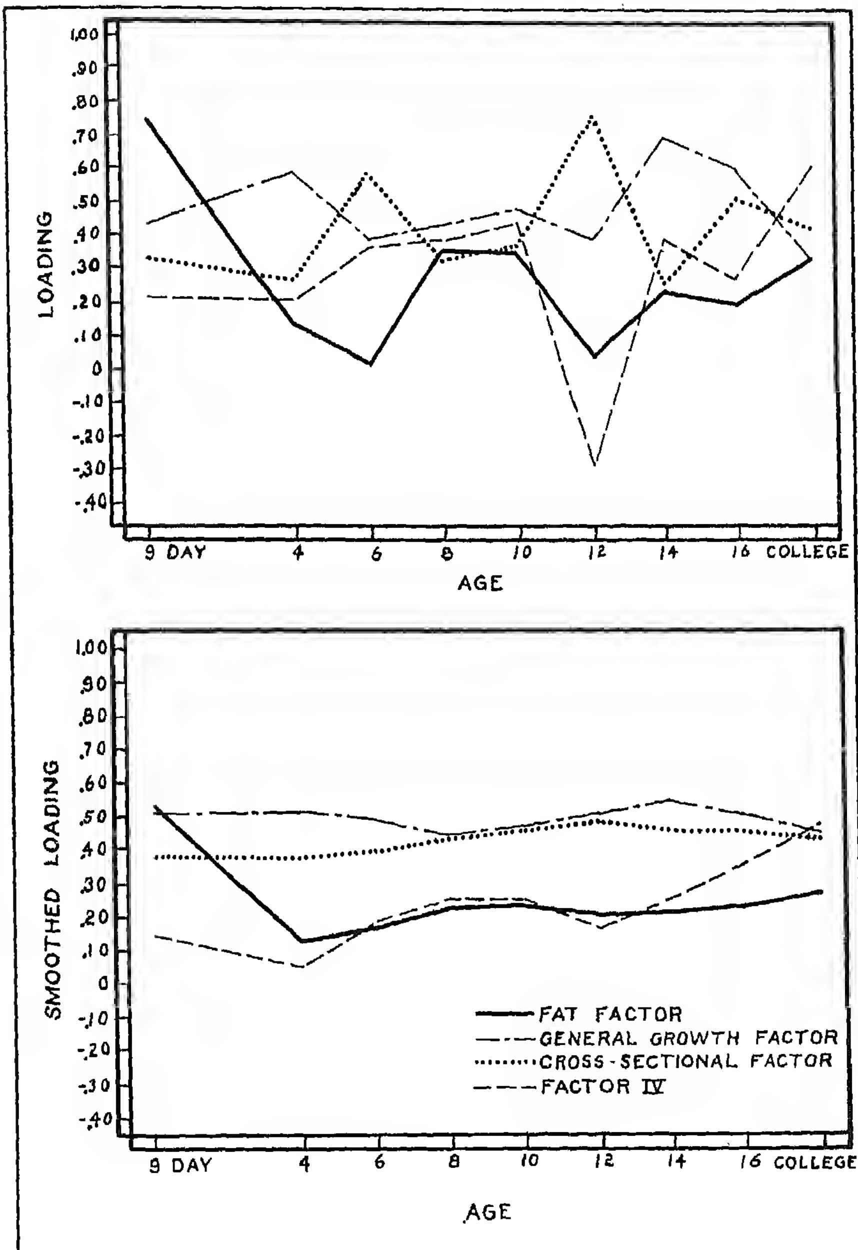
SHOULDER WIDTH (MALES)



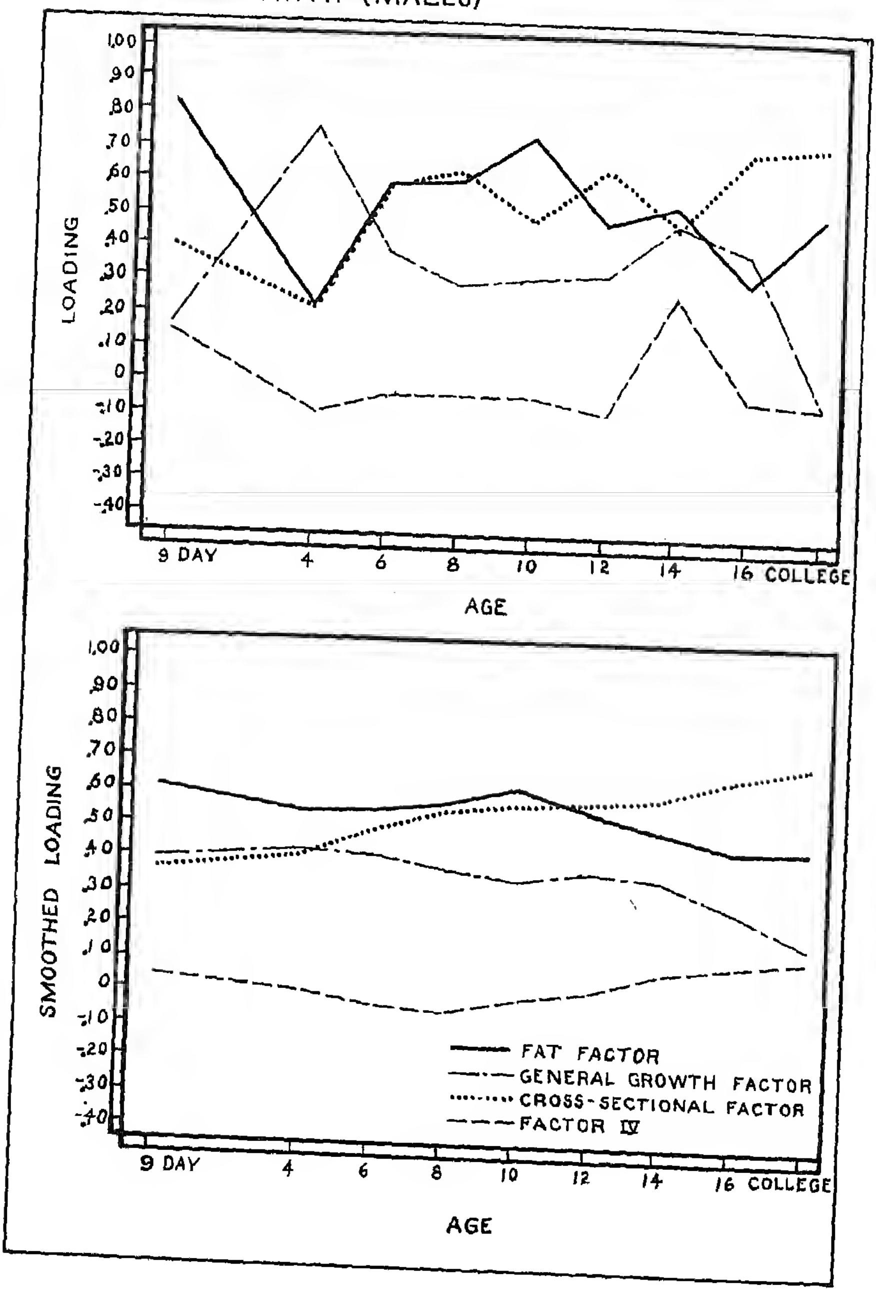
HIP WIDTH (MALES)



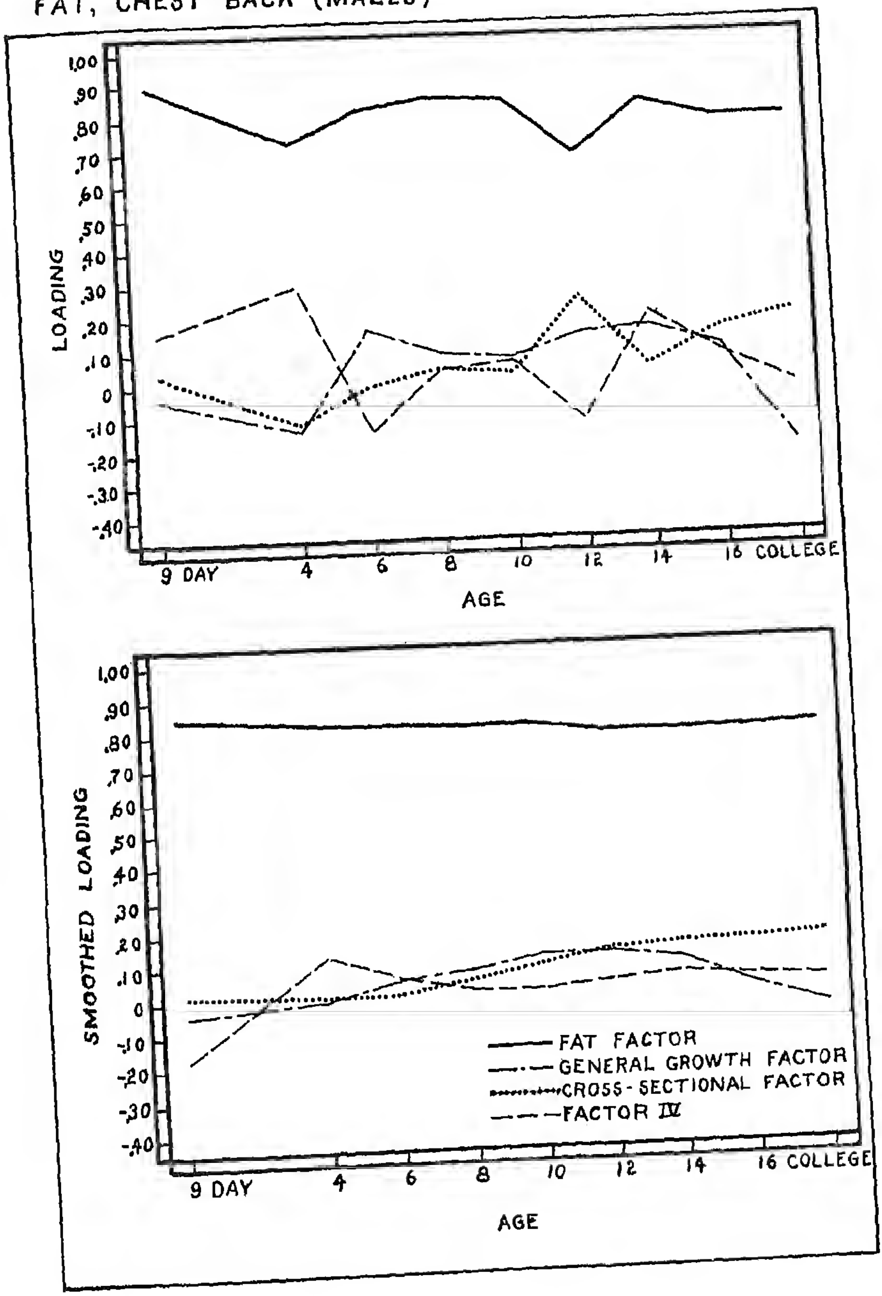
CHEST GIRTH (MALES)



UPPER ARM GIRTH (MALES)



FAT, CHEST BACK (MALES)



TREND IN THE STUDY OF PHYSICAL GROWTH IN CHILDREN[1]

WILTON MARION KROGMAN[2]

Eddington once calculated that if a million and a half people talked continuously for a year enough energy would be created to boil one cup of tea. It is not mere talk we want, therefore, except that discussion be ever the prelude to action. It is in this spirit that I offer the following observations on current trends in the study of the physical growth of the child - a sort of stock-taking, as it were.

The first trend is that of standardization. There have been innumerable osteometric and somatometric studies embracing the bones of the dead and the bodies of the living, ranging from foetus through the senile. We have amassed mountainous piles of dimensions, measurements, indices, formulae, constants, variables, so that of the peoples of the Earth, of the ages of Man, we know race differentiations and racial and individual growth curves. Yet, if we examine this overwhelming bulk of material with the exacting rule of precise comparability we are apalled, as pointed out by Mahalanobis, to find that 80 per cent of it is so much waste effort, only 20 per cent scientifically accurate, methodically comparable. We may offer as an excuse that anthropometry is a relatively new science, that trial and error are the rule of early days of learning, but we cannot accept such evasion any longer. When one notes that leg length may be measured by any one of nine different methods, sitting height by any one of three; that in measuring arm length there are no less than eight postural variants which may defeat accuracy - then, I say, the time has come to look for precise definition of end-point, accurate statement of derived measurement, standardization of instrument, and uniform training of technician. We must never forget that care and experience are inseparable; the two can never be divorced. For some years I have been a member of the International Committee for the Standardization of Anthropometric Technique, working in harmony with the Committee on Anthropometric Interests of the American Association of Physical Anthropologists. We are working on the problems of precision and uniformity; we are assessing end-points and measurements in terms of inherent variability; we are weighing dimensions and indices in terms of import. In short anthropometry is being refined: the mineral shall be kept, the dross discarded.

The second trend is based upon the interpretation of anthropometry from a biological viewpoint. We are, first of all, measuring Homo; there are sizes and proportions that must be basic to Man as an orthograde Mammal, and as a higher Primate; within these relatively fixed physical constants there will be a variability related to sex and to stock or race. We come, therefore, to a classification of measurements proposed and developed at Reserve in the study of male and female American Whites and Negroes.

1) Humanity-linked, uninfluenced by stock or sex. These are umbilical height; length and breadth of hand proportionate to arm; length and

[1] *Revised version of paper read before Child Development Committee of the University of Chicago.*

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breadth of foot proportionate to leg (except in female White); upper face height with minimum frontal diameter and bizygomatic breadth; site of acromiale (except in female Negro).

2) Sex-linked, uninfluenced by stock. These are bi-nipple breadth; vertical dimensions of the pelvis; high heel (in male White); arm-span; transverse chest diameter; relatively short limbs and feet (in female White); relatively short limbs but not feet (in female Negro); head length and circumference, auricular height all relatively small in females.

3) Stock-linked, constant for both sexes of a given stock. These are nipple height relatively greater in Negro; transverse breadth of false pelvis less in Negro; vertical height of pelvis relatively less in Negro; external conjugate greater in Negro; sagittal diameter of chest less in Negro; long limbs are Negroid, especially a relatively long forearm, though not necessarily leg (shin); nasion-nasospinale is less in Negro, nasospinale-prosthion is more; nasal breadth and depth, lip thickness, and interpupillary distance are greater in Negro.

What, you may well ask, does all this have to do with growth? The answer may be given in the form of a paraphrased proverb: "As the tree is inclined so must the twig have been bent." It is probably correct, at this stage of our rather imperfect knowledge of racial growth, to conclude that in achieving an ultimate adult pattern a specific sequence and rate must have been followed. In statural growth, time remaining constant, velocity must be greater in a taller stock, less in a shorter; similarly, bicristal diameter must increase more rapidly in a shorter, heavier stock. So-called racial types of growth remain to be explored; that they exist there can be little doubt. They must be recognized as definite strands in the warp and woof of the growth pattern.

Now, what about the measurements themselves? Are they all of equal reliability, do they all tell their story of growth with equal truth? I cannot answer these questions save by illustrating with the analysis of several of the more routine measurements of growth.

1. Weight
2. Height, vertical and recumbent
3. Sitting height
4. Acromial height (left)
5. Suprasternal height
6. Biacromial breadth
7. Transverse chest diameter
8. Bicristal breadth
9. Chest circumference
10. Entire arm length
11. Hand length
12. Trochanteric height
13. Tibial height
14. Head length
15. Head breadth
16. Head height

Here are certain measurements of body linearity and breadth, of limb linearity, and of cephalic size. Measurements 1, 2, and 6 give increase in dimensions and of general body size, while the difference between vertical and recumbent height is a measure of posture and muscle tone; 10, 11, 12 and 13 are of use in the analysis of limb size and proportion; 5, 7, and 9 are apt to be influenced by respiratory nervousness - they tell as much of emotional stability as they do of trunk growth; 8, if repeated serially, will give an idea of the sex-growth-pattern; 14, 15 and 16 are of use only up to about six years of age; 3 and 4 are so variable, affected by postural adjustments, as to be of limited value.

Thus we see that the measurements themselves, no matter how precise

their definition, how exact their delineation, vary with reference to diagnostic import.

There is another aspect of anthropometry to be noted, namely, the unevenness of incremental growth. Time has no constant value in growth and development; there are "spring-up" and "fill-out" periods; there are spurts of rapid growth, phases of slow progress. But the major theme is one of integration so that spring-up and fill-out, spurt and slow phase, alternate rhythmically to produce balance and at least an attempt towards attainment of an optimum. It is to be remembered that perfection may be the standard, but adequacy is the goal.

I touch upon one more phase of anthropometry and then I go on. We speak quite freely of posture by which we hope to study poise, whereas we actually study pose. Posture is the alignment of the skeleton and muscles of the body in any particular positional pattern. Poise is the delicacy of balance in movement or position. Pose is the self-conscious and even awkward attitude assumed individually under emotional stress, whether from being under observation or in strange surroundings. It must be the aim of the anthropometrist to eliminate pose as a variable factor in the study of the growing child. This can be achieved only if measurer and subject are in absolute rapport.

The third trend is that of the study of the hereditary transmission of physical characters. In a sense the consideration of family-, sex-, and stock-linked characters has already touched upon this theme, for physical traits common to man as Man, man as a bi-sexed organism, man as a racial entity, are transmitted in accordance with biological laws. I would focus attention now upon family-line growth patterns, a theme enunciated by Boas over thirty years ago, but not until recently elaborated.

The recognition of heredity as a broad stream of biologic impulse manifesting itself in generational succession is in itself the best indication of variability. The formative influences in our genetic make-up allow a latitude compatible with the paternal-maternal complex. We still do not know the exact modus operandi of transmission in terms of dominance and recessiveness, but Jennings has shown that what one inherits is certain material that under certain conditions will produce a particular character. The "certain conditions" is the variable here; we strive to hold conditions at a constant and beneficial high level in the hope that the result will be a well-born child. Pearl has shown, however, that on the basis of animal breeding the only reliable test of genetic superiority is the progeny test, the test of the quality of the offspring actually produced. It will be some generations before we can apply this test to Man!

It is quite likely that bodily growth is controlled by at least two sets of genetic factors, the first governing general dimensional growth, the second purely linear or purely circumferential dimensions. Individual differences in pattern - either growth or body-type - are due to the interaction of factors of general size and factors of proportion in the several bodily parts. There is some evidence that the general size factors are the more variable.

Meanwhile we focus attention upon the variants of the "certain condition" mentioned by Jennings. These are the environment in the widest possible sense. To turn to this theme is beyond the scope of this

discussion. We can but cite the nutrition studies of Jackson, the nutrition-illness studies of Bakwin and Bakwin, the generational studies of Boas, the depression studies of Palmer, as proof that the food environment, the socio-economic milieu, the socio-cultural background all register themselves physiologically in skeleton, muscle and tissues. Here is a field of growth studies as yet unexplored, but infinite in its ramifications and of great promise. We must learn family-line type, family economic circumstances, family health history, family social balance and adjustment - in short, the growth of the child is a reflection of his biologico-cultural inheritance immediately through his familial environment, ultimately through his morphologic make-up.

A fourth trend in the study of physical growth is to depend somewhat less upon dimensions and a bit more upon maturation. The assessment of physical maturity via the X-ray is an important feature in the analysis of the "growing-up" process, and is an excellent check on chronological age and physical growth as measured in incremental increase. But even in the maturational theme there are gradations; the order of appearance of centers in infancy depends in part on vitamin elements (especially D) in the diet; this is not so true of the union of centers in adolescence; the progress of ossification in the grade school period is dependent for detail upon health vicissitudes. There are asymmetries in maturation no less than asymmetries in dimensional increase, but the two are not basically related; maturation runs concurrent more with visceral growth, less with size-changes in bodily frame. Changes may occur in bone-ends with no registration of progress in height and weight. Progressive stages of maturation have no direct tie-up with growth, but are a measure of metabolic integration. Discrepancies in maturation bespeak functional inadequacy; discrepancies in dimensions bespeak a more transitory and less deep-seated imbalance.

In the new-born child organs and blood form 35 per cent of body weight, "stores" of growth 65 per cent; of these stores bones form 10 per cent, muscle 20 per cent, fat 35 per cent. In the adult organs and blood are 20 per cent, stored material 80 per cent; of the latter bones form 20 per cent, muscle 40 per cent, fat 20 per cent. The bones are the framework and a storehouse for lime; the muscles give power of movement and store carbohydrates and protein; subcutaneous fat is a non-conductor of heat and a store for the steady drain of energy demanded by growth. Now when we measure stature we get an idea of bone growth but not of developmental growth; when we measure weight we include bone and do not differentiate muscle and fat; the height-weight ratio is an attempt to express proportions of bone, muscle and fat. But these are all estimates of growth, and do not afford a qualitative estimate of maturational progress or well-being. We turn, therefore, to the study of tissues as seen in the X-ray, a study elaborated by Dr. Todd and only in part prepared for publication at the time of his death. It is qualitative and, at the present stage, relatively subjective, but it holds promise of at least partial standardization.

Muscle tone and the composition of subcutaneous tissue have been estimated by clinical assessments of "turgor," and by quantitative measurements, either directly or indicial, as, for example, the ACH index. A lateral X-ray of the hand of a child will demonstrate the density of

muscular tissue very well. Children with "light" muscle shadows fatigue easily, they are prone, likewise, to mental fatigue, with overt symptoms of restlessness, impatience, and irritability; there is apt, in this type, to be a difference of 25 mm. or more between vertical and horizontal height. They demonstrate clearly that often poor posture is due less to habit than to constitutional debility.

Subcutaneous tissue, studied best in an X-ray of the elbow, should show clearly in the X-ray. Density of shadow is an indication of a water-logged and edematous condition, probably due to defective fluid metabolism, particularly manifested in gastro-intestinal allergics.

The skin is thin in infancy, a trifle thicker in later childhood, moderately thick in healthy young adult life, and progressively thinner in middle- and old-age. There should be clear-cut delineation in the X-ray, with perfect definition from subcutaneous tissue, and freedom from edematous folds or wrinkles, seen especially at the wrist.

A fifth trend, and one which I mention with a considerable amount of trepidation, is a closer tie-up between physical growth and mental progress. As late as 1930 Paterson concluded that physiological development and complicated morphological indices of body build were relatively unrelated to mental development. Shortly thereafter, in 1933 and again in 1936, Jones pointed out that any one measure of physical size, with age held constant, and any one measure of mental status were correlated too low (below +.30 and usually +.10 to +.20) to predict one from the other. In 1937 Olson, however, demonstrated that if chronological, dental and carpal ages (the latter two estimates of maturity) be equated with derived test-score ages (mental age, reading age) and dimensional ages (height age, weight age) the curves of progress are comparatively uniform. Within bounds the organism as a whole shows a definite and therefore predictable interrelationship between physical, mental, social and emotional development.

We have, in the past, been comparing two aspects of development - physical and mental - on the basis of yardsticks not comparable, yardsticks calibrated to units of a year, a unit of sidereal and not of biologic time. We must differentiate between trend and phase, must recognize that comparable points may be far apart on the scale of time, and must envisage progress rather than status.

Let me make graphic the points just listed. The body achieves its full dimensional development at about twenty years, and shortly thereafter the adult functional state is reached. The brain achieves its full dimensional growth in six years or less, and from then on time and experience, via training, must develop capacity into ability. Brain is far more dependent than body function upon adjustments to, and acceptance by, the environment. Not only are the time-scales of body and brain growth not comparable, but the very growth processes themselves cannot be equated: body growth is biologic, brain growth and brain expansion (mental development) biological and culturo-social.

I turn, finally, to a sixth trend, namely, the utilization of growth data as the basis of the assessment of well-being. We have long focussed upon the group, and the position of the individual growth curve in the group, and have constructed averages - "norms of mediocrity," Todd called them - degree of departure from which was a measure of aberrancy. We now

look more intently at the individual growth curve as an expression of its <u>own</u> norm. A uniform trend, an even progress to maturity, is the best guarantee that healthy growth is present. A child whose bone mineral, as seen in the X-ray, is deficient, whose muscle shadows are light, whose connective tissues are dense, whose stature increments are poor, whose weight gain is erratic, whose mental alertness is stultified, whose emotional poise is unstable - that child is a sick child, clinical symptoms whether or no!

I terminate these observations with a quotation from C. E. Montague:

> "It is essential to graft upon the bodily sense of sight a special kind of imaginative energy, so that when the fit eye has gone as far as it can, its work is taken over and carried on without a break, so that, when later you try to remember, you cannot say where physical perception stopped and where mental vision began - all you know is that between them they have left you the memory of expanses greater than bodily eye ever say, and also more urgently real than imagination alone could ever frame . . . ."

The study of child development needs just such vision, for we must ever remember that faith is the substance, not the shadow, of things hoped for.

THE CORRELATION OF LANGUAGE ATTITUDES OF DELINQUENT BOYS TO THEIR PREVIOUS INSTITUTIONAL BEHAVIOR

WILLIAM FAUQUIER[1]

Individuals' attitudes are intimately related to definite values which they have established in their struggles to gain and protect feelings of prestige and security. Consequently, attitudes always involve problems of relationship between a person and his environment and may be thought of as being preparatory reactions for actual behavior.

The complex nature and genesis of most attitudes and their continuous change under the influences of daily life make their systematic detection in the clinical situation very difficult. When discovered, however, they indicate the direction and extent of personal difficulty because, as Sherman has pointed out, many attitudes develop as a result of problems and conflicts (10). The determination of attitudinal patterns is, therefore, ipso facto, one of the major problems in the differential diagnosis of children's problems.

In clinical practice a person's attitudes are considered with reference to his background. Theoretically, if the examiner is familiar with the home, school, neighborhood, and special environments of the behavior-problem child and discovers how that child feels about multiple aspects of these environments, he is able to detect the causative factors in the disorder and to substitute treatment which will alleviate the tensions or assist in adjustment to them. Such a diagnostic foundation presupposes, among other things, two factors: first, a reliably accurate and comprehensive sampling of attitudes toward crucial situations; second, the interpretation of these attitudes according to the tenets of some psychological system so as logically to explain the behavior.

With the second factor, interpretation, this study has no dealings, the investigation being limited to a discussion of the factual reliability of verbally expressed attitudes particularly as this pertains to attitudes toward social situations where the subject is able to surmise the desirable and socially approved points-of-view.

The average delinquent boy facing the examiner for the first time is usually conscious of what brought him there, desirous of creating a favorable impression, and frequently comes fortified with a good understanding of right and wrong especially as he must make moral and ethical distinctions in regard to his own activities and inclinations.

Beside being partially unaware of many of his basic attitudes, a boy will commonly evade, distort, exaggerate, minimize, and endeavor to focus attention upon unimportant matters. Hartshorne and May have pointed out that lying and cheating are closely related to classroom association, emotional instability, poor resistance to suggestion, and cultural and social limitations in the home background. "Where conflict arises between a child and his environment, deception is a natural mode of adjustment . . . The motives for cheating, lying, and stealing are complex and inhere for the most part in the general situations themselves. The

[1] *This is the third in a related series of studies conducted at Berkshire Industrial Farm, Canaan, New York.*

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most common motive for cheating on classroom exercises is the desire to do well." (7,412)

For these reasons many of the verbal attitudes expressed by problem children represent merely the level of their social understanding, intellectual acuity, or the dubious results of deliberate or unconscious attempts at deception and fail frequently to reveal the important affective elements which strongly influence his overt responses in frustrating circumstances.

As this study subsequently demonstrates, a high percentage of the language attitudes expressed by delinquent boys do not seem to constitute, without extensive observational opportunities, a sound basis upon which to interpret accurately the specific causes of past behavior or to make reliable prognostications in regard to future conduct. In the normal distribution of children's problems, those cases lying at either extreme of the adjusted-mal adjusted continuum present relatively simple problems in diagnosis. But for each one of these the clinical worker is confronted by a very large number in which attitudes and conduct are not extreme in any sense of the word. These represent the most refractory cases in that their later adjustments frequently show these boys to behave in a very different manner from what one had been led to predict from original examination. This discrepancy between prognostic assumptions and later adjustment is easily explainable if we consider the large disagreement between verbally indicated attitudes and actual inherent behavior potentials.

This paper reports briefly an investigation of the correlation between language attitudes of delinquent boys and their previous related institutional behavior. Although the subjects represent a sampling from a single population, the problems and backgrounds of these individuals are typical of delinquents elsewhere.

METHOD

As a part of the routine record keeping on Berkshire Industrial Farm, a daily report of the boys' misconduct is tabulated at the end of each year. This affords valuable comparative criteria for the measurement of group and individual adjustment. In two earlier studies (5, 6) this procedure has been described. For clarity the record form used in this type of recording is shown in Table 1.

The conduct record of the subjects in this study extends over a period of twelve months antecedent to examination. With knowledge of the type and extent of each individual's overt misconduct during the previous year, a questionnaire was devised to sample the boys' attitudes toward a variety of social situations similar or identical to incidents in which they were reported for socially unacceptable behavior.

The questionnaire entitled, "What Would You Do?" consisted of thirty behavior-situations, ten in each of the three principal categories of the record form in Table 1. To most of the behavior-situations five objective replies were offered, and the boys were asked to check the responses which best represented their points-of-view. Especial care was taken to reduce socially favorable bias by wording the behavior-situations in such a way as to voice antagonistic viewpoints. By this method the possibility of eliciting truthful responses from boys who would ordinarily react

TABLE 1

FORM USED IN THE RECORDING OF REPORTS FOR MISCONDUCT

Name . . . .

Admitted . . . . Born . . . .

		Conduct Reports by Months											
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
AVOIDANCE OF RESPONSIBILITY	breach of routine												
	shirking work or duty												
	missing appointments												
	inattention												
ANTI-SOCIAL BEHAVIOR	stealing												
	lying												
	violence, cruelty												
	destruction of property												
	disobedience to gain end												
INFANTILE BEHAVIOR	runaway												
	temper												
	negative-spite reactions												
	attention getting												
	insolence												
	swearing												
	TOTAL												

in an aggressive and antisocial manner was considerably reinforced. For comparative purposes the responses were weighted according to the maturity of the reply. A high total score represented infantile or antisocial tendencies and a low score being commensurate with good social adjustment. The following examples which include the weights assigned to each response are typical of the thirty behavior-situations.

> Clothes and towels and toys must be kept in their places to keep the house tidy. No one is harmed, however, if once in awhile you forget to put your belongings where they belong. Therefore, if you are punished for such a small thing as leaving your shoes in the parlor, you feel that this is ___ (check one)

- unfair because it is such a small thing. (wt. 2)
- right because boys should never do anything wrong. (fooler)
- wrong because your mother or guardian should pick it up. (wt. 3)
- right because small things are as important as large. (wt. 1)
- wrong because you have committed no crime. (wt. 3)

> All of us want to win success, many things come up to prevent us. We must work and fight to get what we want. Sometimes we are not given what we earn or are cheated. Below are some sayings about getting along in life. Put a (1) in front of the saying you like best and a (2) in front of the saying you like next best. Write only two numbers to show your first and second choice.

- I trust everyone always. (fooler)
- I smash my opponents by fair means or foul. (wt. 4)

- I oppose the wishes of no man. (wt. 3)
- I live up to all rules even if no one else does. (wt. 2)
- I will cheat if I am cheated. (wt. 4)
- I live and let live. (wt. 1)
- I will take the law into my own hands if necessary. (wt. 3)
- A successful man must be hard and selfish. (wt. 5)

Suppose you are in a hurry to go out. You are told that all your sweeping must be done over because there are a few specks of dust on the floor. This seems unreasonable to you. You feel like --

- telling the person to clean it up herself if she doesn't like it. (wt.3)
- arguing about it because it is unfair. (wt. 2)
- swearing under your breath but doing what you are told. (wt. 1)
- laughing and cheerfully doing it because you always mind. (fooler)
- running away because of this unfair treatment. (wt. 4)

The second example is atypical in that eight instead of five responses are offered. The weights assigned to the replies were in all cases conservative. The original plan of weighting from one to five was discarded in many instances when differences were slight or non-essential. In almost every question a "fooler" response was included to measure the presence of self-righteousness or what is often termed the "halo effect."

VALIDITY OF THE QUESTIONNAIRE

Before correlation of the scores with the number of reports for misconduct was made, the questionnaire was tested to determine whether it had been satisfactorily differential in its measurement; that is, whether it showed significant quantitative differences between the scores of delinquents and those of normally adjusted individuals. For control purposes it was administered to a group of subjects from a New York public junior high school who were making satisfactory adjustments to their home, community, and school environments.[2] Table 2 presents the important characteristics of the two groups.

TABLE 2

MEAN I.Q., CHRONOLOGICAL AGE, GRADE, AND MEAN NUMBER OF REPORTS FOR MISCONDUCT; AND NUMBER OF BOYS IN EACH GROUP

Group	Median I.Q.	Median Age	Median Grade	Mean Number of Reports for Misconduct*	No. of Boys in group
Delinquents	93	14-9	7.2	26.75 ± 1.76	73
Normal-Control	90	15-4	8.7	- -	40

*For the normal control group no conduct record was available.

For more critical purposes the delinquent boys were subdivided according to position above or below the mean number of reports for misconduct for the whole group. Two delinquent groups were formed (1) institutional-aggressive boys with a high misconduct count; (2) institu-

[2]The Chatham Central School, Chatham, New York.

tional-submissive boys with a low misconduct count. For purposes of meaningful correlation the questionnaire should show a reliable difference between the mean scores of (a) the delinquent and normal groups; (b) between the aggressive and submissive delinquent groups; (c) between each of the delinquent groups considered separately and the normal group.

For the convenience of recording, the institutional group[3] will be represented by the symbols I-G; the institutional-aggressive group by I-A; the institutional-submissive by I-S; and the normal control group by N-C.

TABLE 3

MEAN SCORES OF VARIOUS GROUPS ON THE ATTITUDE QUESTIONNAIRE

Group	Mean Questionnaire Score	Maturity Ranking
N-C	44.80 ± 0.57	Highest Maturity
I-S	50.81 ± 1.20	Median High Maturity
I-G	54.05 ± 1.29	Median Low Maturity
I-A	62.60 ± 2.45	Lowest Maturity

TABLE 4

PROBABLE ERRORS OF THE DIFFERENCES BETWEEN THE MEANS OF THE QUESTIONNAIRE SCORES FOR THE VARIOUS GROUPS

Group	Probable Error of the Differences Between the Means		
	I-G	I-A	I-S
N-C	6.76	7.1	4.55
I-G		3.1	1.84
I-A			4.45
I-S			

The probable errors of the differences between the means satisfies the standards previously mentioned.

To further demonstrate the effectiveness of the questionnaire, the delinquent boys were subdivided according to their positions above or below the mean maturity score on the questionnaire for the whole delinquent group (54.05) and the mean number of reports for misconduct for these two groups computed. By this procedure an arbitrary misconduct count was obtained for the delinquent boys classified according to their maturity as estimated by the questionnaire score. In Table 5 the high-maturity group is represented by those boys whose score was below the mean for the total delinquent group, and the low-maturity group by boys whose score was above the mean score.

The probable error of the difference between the mean number of misconduct reports for the high-maturity and the mean number for the low-maturity groups is 8.1.[4] This corroborates the data of the previous tables, namely, that for groups a high record of misconduct and a low social maturity are closely related. If the normal control boys were

[3] *Institutional group: total delinquent group undivided.*

[4] *A difference or a statistical constant of any sort is not significant unless it is at least four times its probable error.*

TABLE 5

MEAN NUMBER OF REPORTS FOR MISCONDUCT RECEIVED BY THE HIGH-MATURITY AND LOW-MATURITY GROUPS OF DELINQUENTS*

Group	Number of Reports for Misconduct During Twelve Previous Months	Questionnaire Score
High Maturity Group	19.47 ± 1.03	Below 54.05**
Low Maturity Group	36.82 ± 3.75	Above 54.05

*The mean number of misconduct reports for previous twelve months for the whole delinquent group is 26.75

**See Table 3 for this figure.

similarly subdivided on the basis of the questionnaire scores, it is likely that the boys would fall roughly into two groups - one characterized by mature and tractable conduct and the other by relatively immature and unsocial behavior.

TABLE 6

MEDIAN NUMBER AND RANGE OF "FOOLER" RESPONSES MARKED BY THE BOYS IN THE THREE GROUPS

Group	Median Number of "Fooler" Responses Marked	Range of "Fooler" Responses Marked
N-C	4.25	0 - 16
I-S	4.17	0 - 20
I-A	0.84	0 - 4

The institutional-aggressive boys showed either more sophistication in their choice of responses in that they refused to mark the "fooler" statements or they were more truthful in following the dictates of stronger antisocial feelings. Conversely, the normal control and institutional-submissive boys appear to be more suggestible to favorable social bias or they possess actually a higher degree of socialization. If the behavior record is a reliable reflection of inherent attitudes, probably the latter is true in each case.

CORRELATION OF ATTITUDES TO INSTITUTIONAL BEHAVIOR

The linear correlation between the questionnaire scores of the delinquent boys and their records of misconduct for twelve months previous to examination was $0.55 \pm .058$, many boys with a high misconduct record receiving a low questionnaire score (high maturity indication) and many well adjusted tractable individuals showing a high score (low maturity indication) on the questionnaire.

This discrepancy between verbally expressed attitudes and actual behavior suggests that, even with perfect cooperation from the subject, language attitudes frequently are not reliable indicators of behavior tendencies or potentials. Regardless of the perception of right and wrong, and often despite an honest intention of behaving in a socially sanctioned manner, problem children habitually react in ways which have become strongly fixed due to the motivation of affective forces generated

and maintained by tensions and conflicts within themselves or between them and factors in their environments.

There is an urgent need for clinicians to develop and to utilize a more objective diagnostic instrument, such as perhaps the photopolygraph, not only to supplement the impressionistic interview but for the critical examination of many phychological and psychiatric concepts still in popular use although frequently based on questionable scientific notions.

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TESTS OF MOTOR EDUCABILITY FOR THE FIRST THREE GRADES

AILEEN CARPENTER[1]

In the preschool and kindergarten much of the time is spent in supervised and directed activity, both education through the physical and education of the physical, but when the youngster reaches the first grade most of this is over and he finds himself in quite a different situation. Wellman (6) claims to have shown that preschool education, much of it similar to a good program of physical education, raised the I.Q.'s of the children an average of 8.2 points, which gain lasted through the grades, high school, and college. Not too much is known about what specific activities stimulate the educational development of the child, but it is probable that the responses to the physical educational activities contribute their full share. What then should the teacher of physical education be doing for these first, second and third graders in order to accomplish the most possible in the little time now allowed for such activities? We talk about rhythmic activities, about stunts, about ball handling, and about games, but how well are the relevant fundamental skills taught? And how much is known about the capacities and abilities of the individual youngsters for learning such skills?

McGraw (4) in her studies of identical twins demonstrated remarkable results with the experimental twin, Johnny. He learned an amazing number of skills at an early age. He swam across a swimming pool under water when only ten months old, dived when thirteen months old, and roller skated at sixteen months - apparently only because he was encouraged to respond in situations which were well set. We do not necessarily want all of our Johnnies diving at thirteen months but this does make us wonder a bit how much we may be holding some of these youngsters back by our own inabilities - inability to understand their capacities as much as inability to arrange such stimulating situations.

The achievements of Johnny and the alleged increased I.Q.'s of the preschoolers stimulate in some of us a strong suspicion that a better physical education would not only be good for these youngsters physically but might also go a long ways toward furthering the development of intelligence and general command of the social processes. So why be content with what we have, especially in those lower grades?

We need experimentation in how to do a better job with these children. Experimentation implies measurement. So the tests described in this paper are suggested for a double purpose. Through their use we are able to find out a little more about each student; which is poor in this phase of educability, which needs special work administered with more patience, and which could readily learn more than we are presenting. We have not usually divided the lower grades into squads. Who knows whether or not it would be desirable until we have some valid objective means of making the division? These tests are suggested for such uses.

Still another use of these tests will be as a basis for further research at this grade level. The first, second, and third graders are like the forgotten man! There is much flurry over preschool and kinder-

[1] From Teachers College of Kansas City, Kansas City, Missouri.

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garten education, but almost nothing more is heard of research in the child's physical education until he comes forth into the Motor Quotient, Classification Index and P.F.I. area beginning at about the fourth grade.

The five tests recommended in this paper were taken from a battery of twelve Johnson (1) type tests. Johnson proposed his test for the purpose of sectioning classes into homogeneous units. Later it was shown (2) to be an especially good test of motor educability, the readiness with which an individual learns a new motor skill. If classes are divided according to records made in such a test, those of the high group can be expected to accomplish much more in less time than those in the lower groups. Since many of the test items in the original Johnson battery are far too difficult for children of this age, the author devised a series of nine tests using a modified Johnson mat and added to these the original Johnson tests numbers 1, 2 and 3. For the children of the ages tested it was found that the Johnson mat squares were too large. After considerable experimentation the dimensions of the mats were reduced one-third. Records of these tests were obtained on 128 boys and 125 girls of the first, second, and third grades. Reliabilities were computed for each test. These will be found in Table 1. Tests, C, J, K, and L were found to have reliabilities too low to justify further study

TABLE 1

JOHNSON TYPE TEST RELIABILITIES

A	.7977	G	.8471
B	.7675	H	.8976
C	.6140	I	.6966
D	.7175	J	.6422
E	.8106	K	.4782
F	.8217	L	.5972

so these were eliminated. Each of the remaining eight, with the Johnson total (the combined scores of the eight), right and left grips, and three small muscle coordination tests[2] were intercorrelated and a factor analysis according to Thurstone's method (5), with rotations done two at a time, was carried out. The grips and small muscle coordination tests are not used in this battery of tests of motor educability. They were included in the study for two purposes. First, an additional study has been made of those tests; second, those tests enabled the author to orient the strength and small muscle coordination factor axes in the factor analysis. This enabled us to be much more sure of the identification of the educability factor as such, and to be able to choose the educability tests that were least complicated by strength and small muscle coordination.

Table 2 gives the intercorrelations on which the factor analysis was based. Table 3 gives the resulting rotated factor loadings.

[2] *"Bells" Two desk bells are placed one foot apart so that the child makes movements from side to side in striking first one, then the other bell. Score is number of times bells are struck in ten seconds.*

"Marbles". An open box containing marbles is placed next to a closed box which has a hole one inch in diameter cut in the lid. Score is the number of marbles that the child picks out of the open box and puts through the hole in the second box, one at a time, in thirty seconds.

"Ball bounce". The score is the number of times up to fifty that the child consecutively bounces a rubber playground ball without stepping out of a space one foot square.

TABLE 2

INTERCORRELATIONS ON WHICH THE FIRST TWO FACTOR ANALYSES ARE BASED

	Left grip 2	A 3	B 4	D 5	E 6	F 7	G 8	H 9	I 10	TJ 11	Marbles 12	Bells 13	Ball bounce 14
BOYS													
R.grip	.7183	.2704	.2452	.1832	.1696	.2053	.1999	.2984	.3035	.3275	.2312	.2719	.3579
L.grip		.2105	.2505	.2353	.1771	.1709	.1697	.2293	.2756	.2967	:1877	.2125	.2745
A			.7265	.5526	.4555	.3965	.3358	.4094	.4613	.7383	.2586	.4466	.3461
B				.4464	.4578	.5229	.3616	.3789	.4000	.7158	.2112	.1512	.2848
D					.4148	.4238	.6851	.4491	.4230	.7453	.1171	.2946	.3163
E						.4892	.4863	.4496	.4082	.6800	.2524	.2725	.3195
F							.4096	.5184	.5732	.6894	.2551	.2477	.3717
G								.4451	.4480	.5773	.1116	.1792	.2509
H									.7660	.7406	.2095	.2522	.4571
I										.7088	.1753	.2355	.4219
TJ											.2684	.1900	.4470
Marbles												.5218	.2066
Bells													.2433
GIRLS													
R.grip	.6776	.1727	.1625	.0162	.2758	.2459	.0581	.1972	.1680	.2264	.2711	.1123	.2436
L.grip		.1045	.3789	.0274	.1936	.2777	.1433	.1420	.1621	.2173	.1478	.1836	-.0221
A			.7691	.4294	.5018	.3830	.4568	.2554	.3934	.6120	.4055	.4918	.5829
B				.4611	.3966	.3814	.3745	.2861	.4038	.7058	.3970	.3427	.6315
D					.3725	.3237	.5372	.2939	.3616	.6285	.2806	.2414	.3352
E						.6041	.2867	.3196	.5455	.7067	.3744	.3130	.4513
F							.2618	.3482	.4803	.6699	.3444	.2426	.3417
G								.5133	.3714	.6488	.3668	.2260	.5152
H									.7148	.8236	.3551	.1117	.2256
I										.8236	.3614	.1442	.3226
TJ											.4983	.3222	.3361
Marbles												.4780	.1033
Bells													.4277

TABLE 3

ROTATED FACTOR LOADINGS FROM THE FIRST TWO FACTOR ANALYSES

	BOYS I	BOYS II	BOYS III	GIRLS I	GIRLS II	GIRLS III
R. grip	.7456	.0312	-.0385	.7036	.0041	.0369
L. grip	.6844	.0041	.0036	.6958	.0067	-.0227
A	.2989	.6088	.4204	.2812	.5203	.6342
B	.2239	.6533	.2687	.3135	.5068	.5719
D	.2445	.7032	.0655	-.0241	.6298	.2095
E	.2827	.5881	.1814	.3023	.6180	.1395
F	.3036	.6173	.1207	.4227	.5385	-.0083
G	.2331	.6526	-.0701	.0605	.6329	.2196
H	.4234	.6231	-.1431	.2504	.6977	-.2308
I	.4185	.6410	-.1769	.3245	.7400	-.1840
Total Johnson	.3621	.8902	.1002	.2655	.9949	-.0073
Marbles	.3597	.0676	.5180	.2882	.4321	.2429
Bells	.3544	.1322	.5066	.2857	.2283	.5528
Ball Bounce	.5293	.2408	.2604	.2219	.4406	.4617

In both analyses the Johnson type tests stand apart from the other tests analyzed. Obviously they represent a different factor, one which appears to be a type of motor educability.

A series of partial correlations was then computed. In the computation of these partials the factor loadings with the educability factor were used as zoro order correlations between the test and the factor, and the intercorrelations between the variables were used for the other correlation coefficients necessary to the partial correlation formula. As a result of these partials, it was decided that, for boys, test A could be safely dropped because it makes the same type of contribution as B but does not do it as well. With the girls B was dropped because of its duplication by A. It would also seem from the partials that H could be discarded from the boys and F from the girls. The other partials did not seem to us to justify dropping any of the other tests, so multiple correlations were computed with various combinations of the remaining tests. Table 4 gives the multiples for boys, Table 5 gives those for girls.

TABLE 4

MULTIPLE CORRELATIONS WITH THE EDUCABILITY FACTOR - BOYS

R	0.BDEIH	.8732	R	0.EDI	.8308
R	0.BEFGDI	.8727	R	0.BEFG	.8265
R	0.BGDIE	.8683	R	0.BDE	.8264
R	0.BDEI	.8637	R	0.BGD	.8010
R	0.BGDI	.8597	R	0.BD	.7990
R	0.BEFGD	.8528	R	0.BG	.7654
R	0.BDI	.8501	R	0.BEF	.7648
R	0.EDIG	.8361	R	0.BE	.7279
R	0.EDHI	.8334			

TABLE 5

MULTIPLE CORRELATIONS WITH THE EDUCABILITY FACTOR - GIRLS

R	0.AEGDHI	.9006	R	0.EDI	.8535
R	0.BDGHI	.8997	R	0.BDEI	.8514
R	0.EDHIB	.8894	R	0.EDG	.8127
R	0.AEGDH	.8887	R	0.AEGD	.8134
R	0.EDHI	.8884	R	0.AEG	.7829
R	0.EDGI	.8842	R	0.ED	.7533
R	0.EDH	.8781	R	0.AE	.6641

For boys the combination of four giving the best multiple correlation was B D E I with an R of .864, for girls E D H I with an R of .888. Three of the tests included are identical so B was added to the girls' battery with a resulting R of .889 and H was added to the boys' battery with a resulting R of .872. In both cases the R's are better than those resulting from other combinations of five. Consequently it was decided to use these five tests in a battery for the measurement of this type of motor educability for boys and girls, since in most elementary school situations both sexes are tested together.

From multiple regression equations for each sex the following weightings were computed:

Boys: 1.0458 B + 1.8329 D + .6569 E + 1.0499 I + .7184 H

This was simplified to 1 B + 2 D + 1 E + 1 I + 1 H

Girls: .9887 E + 2.0184 D + 1.6349 H + 1.0245 I + .2363 B
This was simplified to: 1 E + 2 D + 1.75 H + 1 I + .25 B

The five tests were combined both unweighted and weighted for each individual and were intercorrelated with their components, the grips, weight, and a group of speed and coordination tests.[3] All seventeen were then put into factor analyses, boys and girls separately, and the work was done according to Thurstone's method with rotations two at a time. Table 6 gives the resulting rotated factor loadings.

Apparently the Johnsons unweighted and those weighted are of practically the same value in the prediction of this type of educability. A comparison is given in Table 7.

The differences are so small that it was decided to use the five unweighted. This seems especially advisable considering the volume of work eliminated. If classroom teachers are expected to use these tests - and they are - they will be much more likely to do so if the clerical work involved in using the results is kept at a minimum.

Following is a description of the five tests which are recommended and a diagram of the floor plan used in these tests. It can be drawn on the gymnasium floor or playground with alabastine or some other inexpensive cold water paint.

TABLE 6

ROTATED FACTOR LOADINGS OF THE SECOND TWO FACTOR ANALYSES

	I	II	III	I	II	III
		BOYS			GIRLS	
5 Johnsons	.0204	1.0135	-.0204	.0535	.9969	-.0118
5 Johnsons weighted	.0299	1.0054	-.0594	.0787	1.0111	.0038
Weight	.7648	.2073	.2886	.5369	.0276	.2125
Right grip	.9223	.3364	.2038	.6644	.2137	.3208
Left grip	.6287	.3178	.2978	.6669	.2204	.3212
B	.1047	.6738	-.0266	.2523	.6286	-.0705
D	.0998	.6946	-.1363	.0824	.6292	-.1399
E	-.0454	.6742	.0725	.1621	.6638	.0137
H	-.0666	.7808	.0981	-.2206	.7034	.2101
I	-.0533	.7687	.1283	-.1555	.8161	.1658
Standing Broad Jump	.1554	.4624	.5864	.0267	.2908	.5423
30 Yards Dash	.1319	.4134	.5787	.1277	.3429	.5298
Run - over	-.0833	.2817	.6189	-.1247	.2386	.6171
Run - under	-.1045	.4000	.6337	-.0759	.2862	.6604
Run - sit	.1136	.3084	.4708	-.0435	.2022	.6582
Hop	.1493	.3889	.1493	.0798	.5498	.5089
Sargent Jump	.4869	.4687	.4869	.3084	.3747	.4092

[3]"Standing Broad Jump" - Score in feet and inches.
"Thirty Yards Dash" - Score in seconds from a regular start.
"Run and Over" - The child runs twenty-five feet, climbs over a wooden horse two feet high and four feet long, then runs back. A running start is used. Score is time in seconds from moment child crosses starting line until he recrosses.
"Run and Under" - The child runs twenty-five feet, climbs, crawls, or rolls under the horse (see above) and runs back. Scoring and start are the same as above.
"Run and Sit" - Child runs twenty-five feet, sits down on the ground, gets up, and runs back. Scoring and start are the same as above.
"Hop" - The child hops fifty feet on one foot. Score is time in seconds.
"Sargent Jump" - Wall chart method (3) is used.

TABLE 7

A COMPARISON OF THE CORRELATIONS BETWEEN THE FIVE JOHNSON TYPE TESTS WEIGHTED AND UNWEIGHTED AND THEIR VARIABLES

Boys		Events	Girls	
5 Johnson unweighted	5 Johnson weighted		5 Johnson unweighted	5 Johnson weighted
.3832	.3762	Right grip	.2367	.2378
.3169	.3105	Left grip	.1921	.2378
.3280	.3305	Grips	.2471	.2721
.2119	.2089	Weight	.0783	.0613
.7492	.6954	B	.6734	.5398
.7139	.7725	D	.6355	.6503
.7150	.7106	E	.7186	.6160
.8004	.7752	H	.7246	.7773
.7948	.7594	I	.8293	.7837
.4661	.4391	Broad jump	.3046	.2716
.4009	.4205	Dash	.3723	.3415
.2609	.2528	Run and over	.2314	.2926
.3985	.3667	Run and under	.2806	.3383
.2646	.2629	Run and sit	.1781	.2247
.5493	.5573	Hop	.5743	.5521
.4528	.4536	Sargent jump	.3909	.3849

1. Single hop left. (Originally designated as test B.) Hands on hips. Start with feet together behind the first white square on the left. Hop on the left foot onto the first white square, then onto the black square, the second white square, and so on down the mat.

2. Diagonal hop. (D) Start with the feet together on the first center target. Hop with feet together onto the first black square to the right, then to the second center target, to black square on the left and so on down the mat.

3. Backward hop right. (E) This test is the same as the single hop right except that the child hops backward. Hands on hips. Start with the feet together behind the first white square on the right. Hop on the right foot onto the first white square then onto the black square, the second white square, and so on down the mat.

4. Left sideward hop. (H) Hands on hips. Start with left side toward the mat, left foot on the center target. Hop on the left foot diagonally backward to the first black square then, still on the left foot, diagonally forward to the second center target, then diagonally forward to the second black square. Proceed thus along the mat.

5. Right diagonal hop. (I) This test is the same as number 4 except that it is done on the right foot and with the right side toward the finish target.

The tests are scored according to Johnson's directions. Ten is the perfect score from which is subtracted one point if the subject breaks his rhythm, one if he takes his hands off his hips, one for every time he steps over a line or fails to touch the square or center target as directed. He is also penalized a point if he hops forward instead of sideward in tests 4 and 5. If he makes more than ten errors, his score is zero.

Figure 1 gives the modified mat used for the Johnson type tests.

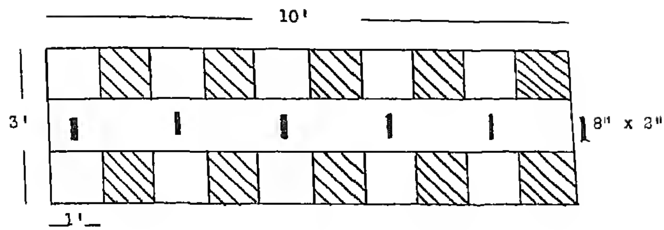

Fig. 1. Modified Mat Used for Johnson Type Tests

The five tests were combined for 213 boys and 217 girls of the first, second, and third grades. The combined scores were correlated with age for the sexes separately and from these were computed the following suggested norms:

Age	Girls	Boys
6	22.38	17.93
7	23.85	19.05
8	25.32	20.17
9	26.79	21.29
Standard Deviation of Estimate	6.39	7.67

While the number of subjects from which these norms were computed is inadequate, it is suggested that they may be used as a general guide until more work has been done. It will be noted that the girls exceed the boys at every age. A suggested explanation for this is that in general while the boys are playing other active games, the girls participate more in such individual activities as hopscotch and jumping rope.

The children enjoy doing the "stunts" involved in these tests. Furthermore, the classroom teacher herself can give the tests and in so doing she will observe more readily the individual differences of the youngsters. She will see that some need more help, more patience, perhaps more detailed directions and demonstrations while others grasp new motor ideas rapidly, coordinate readily and are soon looking for new worlds to conquer.

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COMMENTS ON "THE VARIETIES OF HUMAN PHYSIQUE"

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To an already extensive bibliography on attempts to describe and classify The Varieties of Human Physique, Sheldon and his collaborators have added a 1940 reference.[2] Publication of this book has been awaited for some time. It had been anticipated the book would represent the rigorous reporting of a first-class investigation.

The writer recently read The Varieties of Human Physique. Being actively engaged both in teaching and research relating to the physical growth of the child, he attempted to obtain a reasonable mastery of the book's contents. The task was found to be far from straightforward. At numerous points the report appeared unnecessarily vague or involved. Instances of seemingly ambiguous terminology, confused inference, and needlessly indefinite statement were found to occur with exceptional frequency.

The purpose of this paper is to cite some of the specific material which generated the above reactions, and to inquire whether or not the reactions of others concur. Clearly, then, the paper is not intended to constitute either a systematic review or a comprehensive evaluation. It is no more than a series of miscellaneous comments, addressed to individuals already familiar with the book itself, and directed toward greater clarity and precision in the planning and reporting of "constitutional" research.

THE DATA

Chapter III of The Varieties of Human Physique makes it clear that the major source of data for the investigation was 'the standardized photograph'. Detailed description is given of the equipment and technique employed to secure "exact frontal, profile, and dorsal" (p. 30) photographs of the whole body. It is stated:

> "...a series of standardized photographs of 4,000 undergraduate male students was collected at several mid-western and eastern universities. The ages of these subjects ranged from 16 to 20, with the mean at 18 years, 9 months. In this series the racial element was disregarded, except that Negroes and Orientals were not included" (p. 31).

The basic data were inspectional judgments derived from these photographs. In certain analyses the data were direct ratings from "picture-to-picture" comparison. In other analyses they were separate ratings for each of five regions of the body made with the aid of a check list. (This check list was an itemization of the morphological features found to characterize each of three extreme varieties of physique.)

Besides the reinforcement afforded by the check list, the inspectional data were supplemented with 18 anthropometric indices. These indices were

[1] *From Iowa Child Welfare Research Station, University of Iowa, Iowa City, Iowa.*

[2] *Sheldon, W. H., with the collaboration of Stevens, S. S., and Tucker, W. B.: The Varieties of Human Physique: An Introduction to Constitutional Psychology. New York: Harper and Brothers, 1940. Pp. xii, 347.*

CHILD DEVELOPMENT, Vol. 11, No. 4 (December, 1940)

based on "accurate measurements of height and weight for all the individuals whose photographs had been taken" (p. 50), plus "17 measurements of diameters" taken on the photographs. They represented all of the measurements except stature "expressed as simple ratios of stature" (p. 53).

Summarizing to this point, the basic data appear to have been inspectional judgments of photographs supplemented in part by a check list and in part by anthropometric indices. Analysis of these data ultimately results in a classification of the photographs into 76 physique groups - called somatotypes. Immediately prior to describing each somatotype, the investigators note that their descriptions include "some observations on non-photographable characteristics" (p. 141). The nature and scope of these observations are not discussed.

Proceeding to the descriptions one finds such statements as follow. The 172 "is almost always slow spoken and mild-mannered, and he is not often intellectually inclined" (p. 191). Nearly all the 424's "speak with delicate voice control, and with a voice that is notably sensitive to emotional influence" (p. 167). "The 532's are prone to eat gluttonously... Frequently they are heavy smokers" (p. 198). Do the data include records of speech, observations on eating and smoking, and ratings of manners and inclinations for each of the 4,000 subjects? To continue: "The 252 is...usually fast on his feet" (p. 193). "The 621's are inclined to exhibit great energy" (p. 207). The 117 is "a great walker... striding with a long, springy up-and-down motion" (p. 144). The 226 "walks rather awkwardly" (p. 151). The 127 "is fond of walking" (p. 145). The 162, though "built to stand punishment,...usually lacks the resiliency and the sustained endurance of the professional heavyweight athletes" (p. 188). "The 217 nearly always has poor muscular coordination" (p.147). "All the mesomorphic physiques carry predilection for muscular exercise" (p. 210). The "mesomorphic ectomorphs show an average BMR reading at least twenty points higher than...mesomorphic endomorphs" (p. 233). "...the ectomorph needs to eat oftener than the endomorph or the mesomorph" (p. 248). Certain classes of ectomorphs "seem to be peculiarly resistant to most of the contagious diseases" (p. 145). Extreme ectomorphs are "often singularly spry" (p. 32). The facial bones of the 533, "seen in an X-ray photograph", are slender (p. 185). The wrist bones of the 711, "seen in an X-ray photograph", are not large (p. 206). What are the foundations of each of these statements? Have the investigators accumulated and analysed data on their 4,000 cases from roentgenograms the face and wrist, records of basal metabolic rate, observations on mode of walking, disease histories, and tests of coordination, strength and agility? From what sources, if any, do they draw data for statements such as: "The 117 and the 127 remain at nearly the same weight throughout life" (p. 148); "In the later decades, the 271's tend to grow heavy" (p. 208); Several classes of ectomorphs "are long lived" (p. 145)?

PURPOSE AND PROCEDURE

In Chapter I, the investigators supply the reader with a brief summary of their study. The opening paragraphs of this summary deal with the problem or purpose of the study. The first paragraph states that

the problem was that of "discovering[3] first-order criteria for the classification of human physiques," or of "finding those aspects of grading human physiques which will produce the most fruitful and 'meaningful' schema" (p. 4). The second paragraph, however, claims that "Three primary aspects of bodily constitution were selected[3] for study," this selection being based on the assumption that each aspect was "a component of structure - something which enters in different amounts into the making of a body" (p. 4). What was the purpose of the investigation? Was it first to describe and classify - and perhaps finally attempt to explain - the varieties of physique found in a large sample of white male undergraduates? Or, was it to attempt a classification and description of the physiques of college men in terms of an initially posited theory? The first paragraph appears to support the former purpose and the second the latter.

Careful examination of the procedure followed in the investigation appears to delineate, though not to resolve, this confusion. It will suffice to review a few of the initial steps. These were apparently as follows:

1. The full series of standardized photographs were examined and "precisely three" extreme variants of physique discovered (p. 31). One of these extremes showed "Rugged, prominent, massive muscling. Large, prominent bones." Thoracic volume predominant over abdominal volume. (p. 39) Another was characterized by "Roundness and softness of body." Absence of skeletal or muscular relief. "Predominance of abdomen over thorax." (p. 37) The third had "Small, delicate bones. Slight, 'thready' muscles." Flat thorax and abdomen. (p. 42)

2. The three extreme variations of physique are considered "fundamentally different" (p. 31) and "three elemental structural components are postulated" (p. 46). This postulate is elaborated as implying that the human physique is "made up of an intermixture of components" (p. 29) and every variety of human physique represents "a patterned mixture of these three more or less interdependent variables" (p. 47). At this point it apparently becomes the purpose of the study to determine "what combinations or patternings of the components actually occur in life" (p. 36) and to obtain "a descriptive classification of the patternings of the morphological components" (p. 31).

3. Detailed study was made of "one hundred relatively extreme samples of each of the three variants. These examples were selected by inspection from the 4,000 cases" (p. 36). The object of this step was "to record the characteristics of the three extreme variants, and thereby to define the three morphological components" (p. 36). It is emphasized that the listing of "the characteristics which distinguish the three principal types of male physique as they occur in extreme variations...was strictly empirical" (p. 45-46). Less explicit is the fact that there is transition from an empirical procedure to a rational procedure when it is inferred that the features listed define "basic components." [It should be noted here that in an earlier connection the investigators do state it is their "assumption" that extreme physiques are extreme "because they are dominated each by a different structural or morphological component" (p. 36).]

4. The next step was to arrange the photographs, successively, "in fifteen ascending series, each series based upon the inspectionally estimated value of one component in one bodily region [the body being divided into five regions]. The estimate of a component's value was based simply upon picture-to-picture comparisons in the light of" the lists of distinguishing features discussed above (p. 47). The implications of this procedure are not immediately apparent. The lists gave

[3]*Italics ours. The objective of "discovering" a schema is obviously not synonomous with that of studying a "selected" schema.*

only the characteristics of extreme physiques while the investigators set themselves the task of judging the "strength" of the components along three hypothetically continuous scales extending from these maximum expressions to undefined minimum manifestations.

5. It is difficult to determine the stage at which the investigators came to identify their three "components" with derivatives of the germinal embryonic layers. They introduce this identification prior to discussing their detailed recording of the body features of the extreme variants. Once, it is stated that the identification is "tentative" (p. 111). Elsewhere, however, the components are unreservably referred to as endomorphy, mesomorphy, and ectomorphy. The terms "endomorphic softness", "mesomorphic hardness", and "ectomorphic fragility" are coined and the report is saturated with phraseology like "endomorphic influence", "mesomorphic interference", "ectomorphic increment", "endomorphic set", "mesomorphic skin", "ectomorphic neck", "endomorphic shoulders", "ectomorphic tenseness", "endomorphic concentration", and "ectomorphic brittleness".

It is not necessary to review later steps of the procedure. These are sufficient to make it evident that the procedure involved repeated oscillation from observation to rationale, from description to assumption, from findings to theory. Can the study be regarded either as a straightforward attempt to test a hypothesis or as a rigorous approach to the formulation of a hypothesis? In the continual interplay of systematization of the data and "basic component orientation" (p. 238), which tends to predominate? Is the latter given the leading role and the former used mainly in a supporting manner?

ENDOMORPHY

The term endomorphy is used with the connotation that it constitutes a "basic component" of physique, "derived principally from the endodermal layer" (p. 5). Since the digestive viscera are the only derivatives of endoderm which can be considered to exert a marked differential influence on bodily configuration, the claim is made that "When endomorphy is dominant the digestive viscera are massive" (p. 5). The question now presents itself: Do the investigators base their estimates of endomorphy on determinations of the massiveness of the digestive viscera? Apparently not. At least no clear evidence is presented to show that those college students regarded as "extremes in endomorphy" had the most massive digestive viscera of the entire series. It is true that a student rated an extreme endomorph is described as having a "large and predominent abdomen" (p. 205). However, at least part of this extreme thickness of the "midsection of the body" is credited to "a great roll of fat over the symphysis" (p. 205). Support for the assumed relation between inspectional ratings of endomorphy and measurements of visceral mass rests mainly on autopsy data for intestinal length and weight obtained on thirty-four middle-aged males each rated as predominantly endomorph, mesomorph, or ectomorph.

On what basis then were the so-called "extremes in endomorphy" selected from among the four thousand college men examined? Principally, it appears, on the basis of abdominal bulk in combination with a heavy "overlying blanket of soft tissue and fat" (p. 205). This raises the question, how is it possible for the investigators to regard "conspicuous laying on of fat" (p. 34) as an expression of endomorphy? The answer is found in the fact that they shift their rationale of endomorphy from

structure to function. It is not claimed that subcutaneous tissue is a structural derivative of embryonic endoderm, but the claim is made that fat-deposit is "an indication of predominance of the absorptive functions - the functions of the gut" (p. 34). Have Sheldon and his collaborators overlooked that by the same rationale the absorptive functions of the gut are also basic in the production of mesomorphy, with its "large bones, big joints, and heavy muscles" (p. 32)? Moreover, is it not questionable - since Kretschmer is criticized for employing both structural and functional terms in his classificatory system - whether the authors clearly recognize that they view "endomorphy" partly as a structural derivative of endoderm and partly as produced with the functional assistance of endodermal tissues?

The physique designated 711 is evaluated as "a physique extreme in endomorphy and at a minimum in the other two components" (p. 6). When applied to standardized photographs of the body, does "extreme in endomorphy" mean anything more, or different, than extreme in thickness of subcutaneous tissue and abdominal mass? Were any non-photographic sources of data consistently employed? It is posited that endomorphy "is expressed in the skeleton, in the muscle...in the circulatory system ...and indeed in every tissue of the body" (p.224). What kinds of data and analysis, if any, do the investigators have to support this statement? Certainly it is not supported by their photographs for college men somatotyped 711, since here the reader is informed that whether inspection is made of the trunk region, the facial region or the extremities neither bone tissue nor muscle tissue "shows through". Turning from the matter of the precise meaning of "extreme in endomorphy", it is next pertinent to consider what is implied when the 711 physique is stated to be "at a minimum" in mesomorphy and ectomorphy. It appears improbable that the phrase "at a minimum" is based on any observed morphologic features of the college men to which it is applied. This follows, since in describing the 711's the statement is made that "neither musculatory nor ectomorphic interference shows through at any point" (p. 204). Do the investigators make the unwarranted inference that tissues sufficiently overlaid with subcutaneous tissue as to be no longer indicated are necessarily "at a minimum"?

It appears unequivocal that in describing the varieties of human physique, as in every other scientific pursuit, it is desirable to avoid ambiguous terminology and employ language that is as clear and precise as possible. From this standpoint, appraise the following series of "descriptive" statements. "The whole body [of the 632] is deeply swathed in an endomorphic blanket" (p. 201). The 252 has "a perfect diffusion of the soft endomorphic element throughout the body" (p. 193). In the 452 "There is a softening endomorphic suggestion about the cheeks" (p. 201). The 353 shows "little sign of any special endomorphic fullness over the deltoids" (p. 185), while the 533 is characterized by fairly marked "Endomorphic inflation at the deltoids" (p. 186). "In the 217 the iliac crests are typically covered by a thin endomorphic blanket" (p. 146). The 217 has "just the beginning of endomorphic inflation over the proximal segments of the upper arms" (p. 147), the 362 has an "unmistakable endomorphic suggestion in the upper thighs" (p. 200), and the 434 sometimes has "highly endomorphic legs" (p. 170). In the 532 "there

is a pronounced endomorphic inflation of both thighs and upper arms" (p. 198), whereas in the 126 "neither arms or legs show any trace of endomorphic padding or inflation of the proximal segments" (p. 149). In the 325 "the ankles are sometimes swathed in an endomorphic blanket" (p. 161), while in the 711 "The soft endomorphic blanket covers both the wrists and the ankles" (p. 206). Do the investigators intend these statements to describe anything other than thickness of adipose tissue? If not, what are the advantages of terming a thick deposit of subcutaneous fat a deep endomorphic blanket? In what respects is it in the interest of clear understanding to refer to a physique which appears "completely clean of fat" as manifesting no trace of "endomorphic padding or inflation"? Along a scale of degrees of thickness, are there zones which can be appropriately labeled "suggestion", "fullness", "accumulation", "swathed", "perfect diffusion", "trace of padding", "marked expansion", "pronounced concentration", "great inflation"?

Certain physiques are described as having highly endomorphic shoulders, shoulders with an endomorphic set, or chests distinctly endomorphic in shape. The shoulders of the 542 "are high, with a tendency toward endomorphic squareness" (p. 202). In the 524 "The shoulders have a distinctly endomorphic set" (p. 169). The 613 shoulders are "highly endomorphic (nonprojecting)" (p. 176). "The 424 generally has endomorphic shoulders, i.e., shoulders that are high and square and soft, and that do not protrude laterally much beyond the line of the trunk" (p. 167). In the 522 "The rather large chest is of distinctly endomorphic spherical shape" (p. 194). Why is the term "endomorphic" attached to otherwise clear statements regarding chest shape, shoulder slope, and shoulder projection? Have Sheldon and his collaborators formulated a reasonable hypothesis regarding the relation between derivatives of the endodermal layer and configuration of the upper trunk which they have omitted to present?

ECTOMORPHY

It has been noted earlier that a second of the three elemental components assumed to be intermixed in every human physique is termed ectomorphy. This term, obviously, refers to some sort of entity related to the embryonic ectoderm. What is the nature of this entity or component? Is it a morphologic derivative, a physiologic secretion, a physical radiation? Does it operate selectively or pervasively? That is, does it influence certain segments of the body or all segments; certain organs or all organs; selected tissues or all tissues; selected segments, organs, or tissues at certain ages and other segments, organs, and tissues at other ages? Such questions are, of course, too broad in scope to expect them fully answered by a single study. Are they not, however, such questions as those who wish to assume the existence of the component may reasonably be expected to discuss?

Sheldon and his collaborators state that with increasing degrees of "ectomorphic dominance...the skin and its specialized derivatives predominate over the internal structures" (p. 35). Dominance, in this instance, appears to have a different meaning than that given in the case of endomorphy and mesomorphy. Extreme mesomorphs are claimed to have

more massive bones than individuals low in mesomorphy, and extreme endomorphs to have longer intestines than individuals low in endomorphy. Extreme ectomorphs, however, cannot be claimed to have either a greater amount of skin or a larger nervous system than individuals low in ectomorphy. Consequently, ectomorphic dominance is interpreted not in absolute, but in relative terms. It is "Relative to total bodily mass" (p. 35) that the surface area of the skin and the nervous system are considered dominant. What, then, is the role of the component called ectomorphy? Is it passive, so that the extreme ectomorph is essentially the product of minimal massiveness of bone and muscle tissues and of visceral and adipose tissues? Stated differently, if ectomorphy cannot be shown to manifest itself in varying degrees through the derivatives of ectoderm is it justifiable to assume its existence? Does "ectomorphy" appear to represent a unique structural component which expresses itself in a continuous distribution, or, does it appear to reduce to no more than the slender end of a series of physiques that progressively diverge toward muscular and thoracic stockiness or adipose and abdominal stockiness?

The investigators make the claim their study yields components "which can be isolated in description and gauged in terms of scales" (p. 219). In the case of ectomorphy there is no serious attempt either to describe derivates of ectoderm in college men or to scale any of them. The only approach toward scaling of an ectoderm derivative has reference to skin thickness and texture. This crude grading is made <u>not</u> in terms of the hypothetically continuous variable termed ectomorphy, but in terms of variation between ectomorphy, mesomorphy, and endomorphy. Thus one reads that ectomorphic skin is "thin and dry...resembling the outer skin of an onion" (p. 44), endomorphic skin is "soft, smooth, and velvety, resembling the skin of an apple" (p. 38), while mesomorphic skin is "thick and coarse with large conspicuous pores", resembling the skin of an orange (p. 41).

Descriptions of the different varieties of college-male physique, incorporate such statements as, "ectomorphic triangularity in the face" (p. 195), "the thin sensitive lips of ectomorphy" (p. 197), "ectomorphic tenseness in this face" (p. 203), "ectomorphic neck" (p. 250), "an ectomorphic stoop to the shoulders" (p. 178), "ectomorphic flattening of the upper chest" (p. 178, 187), "ectomorphic brittleness in the distal segments" (p. 195), "ectomorphic fragility...linearity, delicacy, and sensitivity" (p. 179, 171). What meaning accrues from the word "ectomorphic" when it is used to qualify triangularity or flattening or linearity?

SHOULDERS AND HIPS

Turning from questions of rationale to more objective items, one is still confronted with a large number of ambiguities. Many of the statements describing hips and shoulders are either open to more than one interpretation, or, cast in an indirect and indefinite style. Examples are:

1. In the 163 physique "The hips are relatively narrow" (p. 175). Likewise, in the 361 (p. 210). To what does "relatively" refer in these connections? Are the hips narrow with reference to stature, to width of thorax or to shoulder

width?[4] Similar questions arise when shoulders are described as "relatively narrow" in the 623 (p. 180), "relatively broad" in the 162 (p. 180), and "relatively wide" in the 621 (p. 207).

2. The shoulders are "extremely wide" in the 172 (p. 191), "on the broad side" in the 343 (p. 181), "wide" in the 352 and the 245 (pp. 197, 162), "not wide" in the 442 (p. 190), "fairly broad" in the 145 (p. 156), "of medium breadth" in the 434 (p. 170), "rather narrow" in the 533 (p. 185), and "narrow" in the 613 (p. 176). The hips are "broad" in the 631 (p. 211), "often wide" in the 415 (p. 157), "of moderate breadth" in the 442 (p. 190), "on the narrow side" in the 352 (p. 197), "typically narrow" in the 244 (p. 166), "rather narrow" in the 451 (p. 213), "narrow" in the 162(p. 180), and "sometimes extremely narrow" in the 154 (p. 165). Do these statements have reference to actual size (i.e., absolute magnitude)? They appear to. Yet earlier in the report the investigators claim that in their system of somatotyping "absolute size...is canceled out of the reckoning" (p. 53).

3. In the 534 physique "The shoulders are not narrow, but they seem rather narrow, for the trunk as a whole is wider in comparison with the shoulders than is usually the case" (p. 174). Is this an indefinite way of stating that relative to stature the shoulders are not narrow, but relative to trunk width they are moderately narrow? Again, in the 354 physique "The hips seem comparatively narrow because of the wide shoulders, but they are not actually narrow" (p. 172). Is the first part of this statement an indirect way of describing hips that are narrow relative to shoulders? In the latter part of the statement what is the word "actually" intended to imply? Are the 354's 'not narrow' in absolute hip width or in hip width relative to stature? (Table 35, on page 281, appears to indicate that in the typical 354 college male hips are moderately narrow relative to stature.) Would it not be advantageous to report findings such as these positively rather than negatively, i.e., to describe shoulders and hips as "wide" or "average" *rather than as 'not narrow'? Furthermore, would not the value of the* study be greatly enhanced if its findings were reported more specifically, e.g., in college men classified as having a 354 physique, the ratio of hips to stature varied between 18.8 and 19.4?

MISCELLANEOUS AMBIGUITIES

A selected list of other statements considered seriously lacking in precision is as follows:

1. In the 145 physique "The trunk is of variable length, but on the average it shows about the aesthetically popular proportion to length of limb" (p. 156). What is the "aesthetically popular proportion" of trunk length to limb length? Again, part of the description of the 244 reads "There are no morphological peculiarities to mark this physique as departing from good conservative masculine taste" (p. 166). Why introduce such an undefined phrase as "good conservative masculine taste"?

2. "The 162 suggests strength, with little weakening at the extremities of the arms and legs" (p. 188), while in the 326 "The chest is relatively weak... Weakness is seen in the inner aspect of the lower thighs...and the forearms and lower legs appear particularly weak" (p. 155). Why not describe structure in structural terms? What are the morphologic hall-marks of "strength"? What are the specific criteria of chest weakness, forelimb weakness, and thigh weakness? What distinction is intended when reference is made to "a slight slendering, rather than a weakening, of the wrists and ankles" (p. 189)?

3. The 145 is "a fairly rugged and muscular youth who is also markedly lean and brittle in appearance" (p. 156). In what sense may a physique be considered

[4] *Since at one stage of the study ratios of hip width to stature were calculated, the initial assumption of the reader is that whenever "relatively" is used in describing hip width it implies 'relative to stature'. On reading passages like "The hips [of the 171] are relatively narrow when compared with the shoulders" (p. 204), this assumption becomes untenable.*

both "rugged and muscular" and "lean and brittle"? In the 126 "The extremities appear fragile and brittle, but the physique as a whole suggests action, speed, and clean quick movement. This is a tense and unrelaxed, if not an unrelaxable, physical constitution" (p. 148-149). Given standardized photographs of individuals standing in the erect position, what are the indicators of brittle extremities, unrelaxable constitution, and tendency to quick movement?

4. In the 316 physique "The back is weak, waist high, and the hips wide. The lower legs and arms look like slender stilts which are strikingly white and appear devoid of muscle" (p. 153). What are the structural earmarks of a weak back? Is the waist high in relation to stature, trunk length, or both? Are the hips wide in relation to stature, to shoulder width, or to the hip widths of other college men? By what clues may one recognize forearms considered "devoid of muscle" - are the shafts of the radii thrown into relief?

5. "The 335 is still a pronounced ectomorph but the sharpness of feature and the lean sensitivity of the body are blanketed with a softening first component like a rock quarry with a carpet of snow" (p. 162). What is "lean sensitivity"? In the 612 "The arms hang loosely and nervelessly, like useless flippers" (p. 190). "In the endomorphic 7's the arms and shoulders are relatively insignificant appendages, like those attached to rubber dolls" (p. 209). The face of the 261 "suggests the resilience and toughness of high-grade solid rubber" (p. 206). Are any of these analogies compatible with the level of exactitude which research on human morphology reasonably can be expected to attain?

6. Reference is made to the 346 youth "who in his teens looks more ectomorphic than he is" (p. 163). If interpreted as a comparison of the 345 physique at different ages, this statement appears to imply that the 345 is more ectomorphic in his teens than he is as a young adult. If interpreted as applying exclusively to the teens it appears to say nothing more than the 345 youth looks more ectomorphic than he looks. While the latter interpretation yields a self-contradiction, it also appears unlikely that the former is intended since the investigators state elsewhere, "the impression appears warranted that the somatotype is definitely fixed before birth" (p. 158). Is there a third alternative? Might the statement be interpreted to mean that standardized photographs of the 345 "in his teens" are judged differently at first glance than after more thorough inspection?

7. In the 325 "the shoulders are relatively narrow and often drooping, the chest is more or less slumped...and the wrists are likely to seem extremely slender" (p. 161). "The 425 is a stronger and less collapsed 415... The extremely weak neck, fragile facial structure, collapsed chest, and narrow shoulders of the 415 have all been somewhat strengthened, but this is still a weak physique. There is general relaxation and the suggestion of flaccidity throughout" (p. 162). Italics ours. Is such indefiniteness unavoidable in research on the variations of human physique?

SUMMARY

A study on The Varieties of Human Physique was recently reported by Sheldon, Stevens and Tucker. It is the purpose of the present paper to place some comments on this study before the readers of Child Development. The comments are organized under six selected headings: The Data, Problem and Procedure, Endomorphy, Ectomorphy, Shoulders and Hips, and Miscellaneous Ambiguities. They are made with the sole intent of stimulating greater clarity and scientific rigor in the research area to which they apply.

BILATERAL MANUAL PERFORMANCE, EYE-DOMINANCE AND READING ACHIEVEMENT

GERTRUDE HILDRETH[1]

This study reports the performance of young children in using both hands simultaneously for copying figures. The data obtained in the experiment reveal the developmental trends in this performance through several successive age groups and shed some light on the relation of handedness, eyedness and reading performance. The method offers new possibilities for research in child development. It has previously been shown by Van Riper (2) and others that simultaneous bilateral drawing gives a reliable measure of handedness.

Some years ago Fuller (1) effectively demonstrated that simultaneous writing or drawing by the two hands is naturally identical but opposed. The natural orientation of the two hands is isotropic with reference to the body axis. In mirror-writing the kinaesthetic sensations agree with those of the correct writing with the dominant hand. In the normal right-handed person, mirror writing with the left is the typical automatic motor expression involving only the primary central motor apparatus. Mirrored left-handed script is normal for the young, dull, untaught person, or one who is responding automatically, rather than on an attentive level. The neural-muscular apparatus favoring reversals or mirroring is therefore always potentially present. Reversing the direction of the two hands in drawing the same figure simultaneously is a normal performance. The higher intellectual processes can inhibit this tendency, through learning or conscious attention. The unilateral movement when the two hands function together in drawing is the result of training, insight and sophistication.

The left and right orientation of objects in space is naturally elusive. Correct orientation is difficult for young children to acquire. Confusion may persist for years in spite of systematic training, but practice ordinarily helps establish correct orientation habits. Visual and kinaesthetic learning are involved in acquiring the correct eye-hand coordinations.

THE EXPERIMENT

The test used was constructed for purposes of the experiment. Fifteen figures were drawn on white flash cards measuring approximately four by ten inches, one figure on each card. (See Figure 1). The last four figures contained familiar letters and numbers. The others were meaningless symbols. The first item was a square. Each child was tested individually. The child was seated before a board to which ordinary letter sized paper had been clipped, after being ruled down the center. He was told that he would be shown a series of pictures on the white cards, and that he was to attempt to copy each figure using both hands at once, and pencils of equal length and sharpness. He was instructed to keep the

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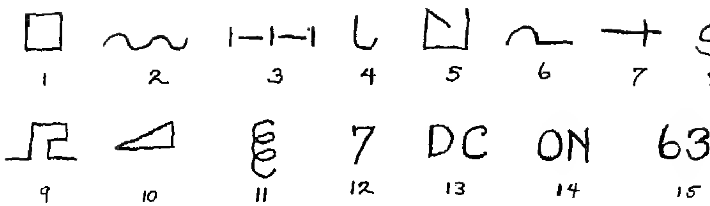

Fig. 1. Figures used in the Bimanual Drawing Test

drawings of one hand on the right side of the vertical line, drawings of the other hand on the left.

As each child worked the examiner made marks on the child's paper indicating the direction in which the drawing with each hand was done. The flash card for each succeeding test served as a screen to prevent the child from observing that such marks were being made.

This was a new experience for all of the children and naturally difficult for the youngest nursery school and kindergarten groups. The great advantage of the test is that it was a novel experience for the child and enabled the examiner to observe the performance of the two hands simultaneously under identical conditions.

For testing eyedness two methods were used: Parsons Manoptscope: an aluminum cone placed over the eyes, with an opening at the smaller end, which the subject directs toward the object of vision. The peephole method was used as a check test. A cardboard containing a quarter inch hole was held before the subject's eyes by the subject himself, and was fixated on another card at several feet distance, containing a black ink dot. The position of the card over the subject's eyes, indicated right or left-eyedness. Both tests are somewhat subject to hand dominance, unless unusual precautions are taken in examining.

Handedness was judged from the performance on the bimanual copying test, and teachers' observations. A child was rated as right handed who used the right predominately in unilateral activities, e.g., writing, ball throwing, eating.

Reading was checked systematically at the end of the school year with routine school tests, part of the regular achievement testing program. Although the same tests were not used at different grade levels, grade scores made it possible to compare results.

The total number of children tested was 103, 57 boys and 46 girls, in six groups ranging from nursery level to third grade, in age from four to nine and a half, all the cases that were available at the time in the school.

The children were above average in height, weight, economic and social status, intelligence, social background, and they were all in good health.

Scoring. Children's responses were scored in four categories: 1. Item correct, movements in drawing made simultaneously and identically. 2. Mirrored or reversed result, full or complete reversal. The drawing pattern of one hand the opposite of the other. 3. Partial mirroring or figure reversal. 4. Other response involving some error.

Results for all the varied types of error were not fully analyzed, since I was not so much concerned with exactness in drawing as in the reversal or mirroring feature of the drawing activity.

A "reversal" in a unilateral figure or a bilaterally symmetrical figure such as a square can be noted only in terms of the movement of the hands in drawing it, not in the way the figure "faces" after it is completed. This is the case with items numbers 1, 2, and 3; and the "O" of number 14.

Children's Reactions to the Test. The children were naturally curious about the test. Most of them thought it had something to do with determining which hand was better. One boy of eight asked, "Is it a test of ambidexterity?" Another, "Isn't it for nervous reactions?" Most of the older children tried to identify the figures as something familiar. This seemed to make the drawing task easier.

In the course of testing, differences in personality showed up. It was possible to observe disorganization and disintegration, resistance, mental dullness. The learning process during the test was interesting to observe.

Results. Three children in the nursery group had non-scorable papers. All others could be rated according to the scoring scale developed. The hands of the younger children sometimes tended to separate during the drawing, and the results thus produced were counted wrong. Actually there was less mirroring when the hands performed separately.

Bilateral Score in Relation to Age

Age	Correct	Average Score: Mirror or Reversal	Part Reversal	Other	Number of cases
Under 5	1.43	3.29	.715	5.14	7
5 to 5-11	3.89	6.91	3.085	1.16	14
6- to 6-11	7.94	5.05	1.28	.61	18
7 to 7-11	10.4	3.78	.66	.01	27
8 to 8-11	10.5	3.22	1.26	.002	27
9-0 to 9-6	13.7	1.			13.

Mirroring was quite universal among the five-year-old children. The mirroring seemed to be a very natural performance. There was little evidence of conscious effort to make both hands move in the same direction.

The mirror tendency, however, steadily declined with age. The number of partially mirrored items and other errors also declined. The oldest group had almost perfect papers.

Sex Differences. Do boys show more natural mirror tendency or more confusion than girls? Since the number of boys and girls was similar and the age distribution in the two groups about the same, a comparison was made of scores for the two groups.

Sex	Average Correct	Number of cases	Mirror: Average Reversed	Number of cases
Boys	8.4	56	4.7	55
Girls	9.06	46	4.21	41

The scores show only a negligible difference in favor of the girls in the number of perfect drawings made on the average. Girls tended to make slightly fewer mirror responses.

SUMMARY FOR THE FIFTEEN SEPARATE FIGURES

Do some items in the series cause more difficulty than others? We can not know the absolute difficulty of the separate items without giving the items again in rearranged order, and this has not yet been done.

What was the difficulty order as the series was presented in this experiment? The following table shows the number of times each item was correct or reversed.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Correct	19	50	39	75	74	72	55	58	64	84	66	74	69	54	66
Reversed	79	48	55	20	20	23	41	36	23	22	20	23	1	2	2

In order of frequency, number correct *and number reversed, the* results are as follows:

Correct - 10,4,5,12,6,13,15,11,9,8,7,14,2,3,1
Reversed - 1,3,2,7,8,9,12,6,10,4,5,11,14,15,13

The item most frequently correct in all papers was the tenth, a triangle; the item most frequently reversed was the first, a square. The order in which the item occurred was probably a function of difficulty. All the earlier items were more frequently mirrored than the later items, yet intrinsically they were not more difficult.

Improvement was frequently shown in comparing the last half with the first half of a subject's performance. This tendency to improve in the test itself steadily increased through the age groups up to the point where there was little room for improvement.

Orientation, left or right, may be a more subtle feature of the square because it has no obvious direction as an object such as a triangle *or other lopsided figure would have. The curved and closed items* seemed to lend themselves more to mirroring than other items. The familiar letter and number items (except for ON) were easier, and the simpler, unfamiliar figures appeared to be easier and less subject to reversals.

Items 11 and 9 were hard items because of relatively complex motions needed in performance. On these items the children studied harder and made more conscious effort to draw correctly. Figure 10 was easy to draw.

DIRECTION OF MIRROR ORIENTATION

When reversible figures are mirrored in which direction, right or left are they reversed?

Of all items mirrored, 191 in all, 152 items showed left mirroring, left hand figure inverted, only 39 right mirroring, right handed figure inverted. Furthermore, left mirroring tended to increase in the older age groups. Four times as many figures were mirrored to the left than to the right. This mirroring was done by the left hand in practically all cases.

The Factor of Intelligence. What is the association between intel-

ligence and mental maturity to these scores? Through all the age groups, the scores, on the average, of children under 112 I.Q. were compared with those rating over 125 I.Q. on the Stanford Binet test. This variation in I.Q. was chosen so as to have an adequate number of children and an equal number in the two groups.

Results	Correct	Mirror or Reversal	Part Mirrored	Other	Number
I.Q. over 125	10.6	3.2	1.17	.2	23
I.Q. under 112	7.05	4.4	.9	2	22

There is some relation between lack of mental maturity and mirror tendency in this test; between success and ability. A wider ability range would probably tend to show still more difference. Our results are doubtful because of the small number of cases. Our clinical observation of the children at work proved that the immature children whether young or comparatively dull had more difficulty with the test than older and brighter subjects.

Relation of the Bilateral Test Scores to Reading Achievement

Grade Score in Reading	Correct	Mirror or Reversal	Part Reversal	Other	Number
No reading skill	2.94	5.65	2.2	2.5	17
1.1-1.5	6.41	5.67	1.17	1.8	12
1.6-2.5	8.07	5.42	1.33	.15	14
2.6-3.5	8.5	4.45	1.75	.25	18
3.6-4.5	11.55	2.7	.62	.04	16
4.6-5.5	10.25	3.17	.75		12
over 5.5	12.9	1.5	.5	.08	12

These results show a gain in the drawing test scores and reading achievement up to the fourth grade level. It is reasonable to suppose that the steady practice in left to right orientation that successful reading achievement affords would help in overcoming natural mirror trends, but the relationship suggested in this table may be associative rather than causal.

COMPARISON OF SCORES, RIGHT- AND LEFT-HANDED SUBJECTS

Do left-handed children show more mirror and reversal tendency than right-handed children? The number of cases of left-handed children was small, 14 or 13 per cent in all the groups. This included those who were left-handed at the time of the test, or were reported to have been left-handed formerly and to have been shifted partially.

These cases were matched for age, sex and I.Q. with subjects who proved to be right-handed at the time of the test and were reported always to have been right-handed.

One and a half times as many items were mirrored by the small group of left-handed subjects compared with a matched right-handed group.

	Results			Test Scores	
	Average Correct	Average Mirror	Average Part Mirror	Other	No. of cases
Left hand	9	4.7	1.14	.14	14
Right hand	11.7	3	1.14		14

Most of these children are not clear cases of left-handedness, but had been shifted to right, especially for writing activities, hence they might tend to suffer more orientation confusion than other children. Several cases of left-handed children who had never been shifted did little mirroring.

EYEDNESS AND BILATERAL TEST SCORES

What is the relation between the drawing test scores and eyedness as measured by appropriate tests?

RESULTS

Eyedness - Both tests, Manoptscope and Card

	Right (both)	Left (both)	One test right, one test left
Percent	49	39	12

Manoptscope only (the more reliable test since it is less affected by handedness)

	Right	Left
Percent	52.3	47.7

Trends were similar from group to group with both tests. Handedness appears to affect these results to some extent.

RELATION OF EYEDNESS TO HANDEDNESS

Right and left eyedness was almost evenly divided among good and poor scorers on the test. No association could be discovered between eyedness, left and right, and score on the drawing test.

CONCLUSIONS

1. The Bilateral Drawing test results prove that unilateral orientation in drawing when the hands perform simultaneously is a function of mental development and maturity. This orientation is achieved in part through practice and learning, through conscious effort. It in time surmounts the more natural automatic tendency to move the hands in opposite directions when drawing simultaneously. The vanishing point for this type of error may not be reached until adulthood, but nine year old bright children are rapidly approaching maturity in this respect.
2. Simpler figures and those more closely related to writing practice cause less error and mirror tendency than other more complicated or unpracticed figures.
3. Confusion due to shifted handedness may prolong the mirror ten-

dency. In the older child reversals are significant of immature orientation.

4. The tests prove useful in clinical diagnosis, first for detecting manual dominance with more accuracy, and second in studying the individual child's developmental status in manual orientation. We advocate its use with all handedness problems and children who seem confused in reading and writing. Similar studies should be carried on with children of average intelligence in all age groups.

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THE PLACE OF STATISTICS IN STUDIES OF CHILD DEVELOPMENT[1]

EDWIN B. WILSON[2]

When Dr. Stuart asked me many months ago to say something at this meeting of the Society for Research in Child Development about the place of statistics in their work I supposed that I should be tucked in somewhere in a session attended chiefly by statisticians and others who were primarily interested either in statistical methods or in the results of their applications. It came therefore as a surprise, if not as a shock, to me to learn relatively recently that I was to be an evening after dinner speaker. Only once I believe have I had to serve in that capacity with a scientific and technical discourse. That was when in 1927 at Cincinnati I gave at the request of Dr. George Kline, our Commissioner of Mental Diseases in Massachusetts, the Presidential Address before the American Psychiatric Association. It seems that that association is so sane that they have the President's address given by a guest speaker. Some of the members certainly enjoyed my address - they told me so, and I am sure some of them must have spoken truly for I had noticed them sound asleep.

We tend to drive very hard here in America. It may be doubted whether it is hygienic to finish off six hours of scientific sessions with a continuation thereof in the evening when you have to face six hours more on the morrow; but hygienic or not it is our wont. And that I suppose is the life for which you are developing these children whom you study. You are particularly bears for punishment when you venture upon a discussion of statistics after so many weeks of the strident shrieking of statistics in the papers and over the air in one of those long drawn out quadrennial contests before the American Electorate. I could well imagine that you had had enough of the subject. Wasn't it Mr. Roosevelt who spoke of the cruel Republicans which left the farmer 10 cent corn and 20 cent wheat? And did not Mr. Hoover answer him that it was 35 cent corn and 60 cent wheat? And did he not go on to say that when Mr. Roosevelt spoke of 20 cent wheat instead of 60 cent wheat he was 300 per cent wrong and 350 per cent wrong on the matter of corn? Which of the two is the better or the worse statistician, I do not know. There are many prices of wheat and corn according to time and place. Was one referring to prices on the farm and the other to prices in Chicago - were the times also different? I do not know. You do not care.

Seeing, however, that we are speaking of statistics did you stop to wonder how anybody could be 300 per cent wrong if the price of wheat really was 60 cents, except as he stated the price to be $2.40. But you must readily admit that 300 per cent sounds a deal more serious than 66-2/3 per cent, and that the prime purpose of a political campaign is perhaps not so much truth as success. For that reason I will not further pursue the deluge of numerical so-called facts which has recently been poured out upon us. I wonder how many of the electorate are deceived by such facts - or even pay any attention to them.

[1]*Address presented at the dinner of the Society for Research in Child Development, in connection with the Fourth Biennial Meeting of the Society at Harvard Medical School, Boston, Massachusetts, November 8-9, 1940.*

[2]*Professor of Vital Statistics, Harvard School of Public Health.*

Not all our facts come to us in numerical form. There are clinical observations which are expressed in words like many historical occurrences. Did you for instance hear the impressive voice from the Hollywood for Roosevelt program quoting with emphasis Geo. Washington's letter to Lafayette? "There are other points in which opinions would be more likely to vary. As for instance, on the ineligibility of the same person for president, after he should have served a certain number of years. Under an extended view of this part of the subject, I can see no propriety in precluding ourselves from the services of any man, who in some great emergency shall be deemed universally most capable of serving the public." As the program went off so rapidly I cannot say just how much of the appropriate passage from this letter was quoted. Let me give you the whole of it.

To Marquis de Lafayette — Mt. Vernon, 28 April, 1788

"There are other points in which opinions would be more likely to vary. As for instance, on the ineligibility of the some person for president, after he should have served a certain number of years. Guarded so effectually as the proposed constitution is, in respect to the prevention of bribery and undue influence in the choice of president, I confess I differ widely myself from Mr. Jefferson and you, as to the necessity or expediency of rotation in that appointment. The matter was fairly discussed in the convention, and to my full conviction, though I connot have time or room to sum up the argument in this lotter. There cannot in my judgment be the least danger, that the president will by any practicable intrigue ever be able to continue himself one moment in office, much less porpetrate himself in it, but in the last stage of corrupted morals and political depravity; and evon then, there is as much danger that any other species of domination will prevail. Though, when a people shall have become incapable of governing themselves, and fit for a mastor, it is of little consequence from what quarter he comes. Under an extended view of this part of the subject, I can seo no propriety in precluding ourselves from the services of ony man, who on some great emergency shall be deemed universally most capable of serving tho public."[3]

That looks tolerably convincing. Washington was not against any third term - at least not when he was writing this to Lafayette. The date shows that the letter was written during the time between the constitutional convention and the adoption of the constitution by the States. Washington was then devoting his energies to its adoption by the States. He had had no experience in the Presidency. He was admitting that the constitution was not perfect, that it could be amended, but was holding that first of all it should be adopted so that the government of the country could get going. It might be possible in view of many considerations to claim that he had just got into the habit of defending the constitution to forward its adoption and that he did not take very seriously his position against limitation in the total term of office.

However that may be, did you receive as I did from some unknown person a copy of the cogently written address of President Wriston delivered under the auspices of the associated Willkie Clubs of Rhode Island? Dr. Wriston, you know, was a student and teacher of history in earlier times before he came to preside over our neighboring institution with its strong department of history and its excellent historical collections, particularly Americana. Let us hear Dr. Wriston:

[3] *W. C. Ford, Writings of Geo. Washington, vol. 11, p. 257.*

"George Washington established the two term precedent. He knew that what he did would determine the pattern of procedure under the Constitution. He felt a deep sense of responsibility not to set bad precedents. Being a thoughtful and careful man, he took advice, and weighed it with the greatest care. The matter of accepting re-election was no exception and he decided against a third term not only on personal grounds, as has so often been said, but on grounds of public policy. *What were these grounds?*

"Washington said that a change in office of president was "more congenial *with* --- liberty and safety". *So fully* was he persuaded of that fact that he preferred one term to two and would not consider a third term under any circumstances, though he could have had it without asking."

I must not quote more of this very convincing address. You see Washington wae unalterably opposed to a third term and even preferred one to two. Do you bet on Washington to Lafayette and Hollywood for Roosevelt or Dr. Wriston with his quotation, the source and date of which was not given though doubtless known to all historians and certainly not difficult for anybody to run down. At the risk of boring you I will tell you where it comes from. Early in the fourth year of his first term Washington told several intimates that he did not wish a reelection and he was turning over in his mind the substance of a farewell address which he wished to make on retiring from public office - as he had made one in retiring earlier from the highest military office. On May 20, 1792, about four years after his letter to Lafayette, he wrote to James Madison sending him a long but rather sketchy draft of his farewell address and asking him to look it over, suggest changes, or recast it as he saw fit. But let Washington speak for himself:

To James Madison — Mt. Vernon, 20 May, 1792

"---as the recess may afford you leizure, and I flatter myself you have dispositions to oblige me, I will, without apology, desire --- that you would turn your thoughts to a valedictory address from me to the public, expressing in plain and modest terms, that having been honored with the Presidential chair, and to the best of my abilities contributed to the organization and administration of the government --- and the spirit of the government may render a rotation in the elective officers of it more congenial with their ideas of liberty and safety; that I take my leave of them as a public man."[4]

I will not quote this letter further. It makes interesting reading for itself and for its comparison with the revised draft which Madison prepared. Whether now in May 1792 Washington really meant to state solemnly that the spirit of the government may render a rotation in the elective officers of it more congenial with their (the public's) ideas of liberty and safety, I do not know. He had had three years of actual experience as president and there is some evidence that he had run into some unexpected and unhappy experiences which may well have caused him substantially to revise that full conviction which he had from the fair (but theoretical) discussions in the convention. At any rate Madison took him literally at his word and in his draft put the matter as follows:

[4] *W. C. Ford, Writings of Geo. Washington, vol. 12, p. 126.*

To Geo. Washington Orange June 31, 1792

"May I be allowed further to add, as a consideration far more important, that an early example of rotation in an office of so high and delicate a nature may equally accord with the republican spirit of our Constitution, and the ideas of liberty and safety entertained by the people.

"Under these circumstances a return to my private station, according to the purpose with which I quitted it, is the part which duty as well as inclination assigns me.---"[5]

Washington did not complete his farewell address at this time, he was persuaded to permit himself to be elected for a second term. Early in the fourth year of that term he again took up the matter. At this time Madison seemed not to have been so close to him; he sent Madison's draft, with a preamble added and with other modifications, to Hamilton with a request for suggestions, even extending to a recasting of the whole. One of the modifications consisted in leaving out the paragraph: "Under these circumstances a return to my private station, according to the purpose which I quitted it, is the part which duty as well as inclination assigns me.---" He did not, however, delete or modify the preceding paragraph: "May I be allowed further to add, as a consideration far more important, that an early example of rotation in an office of so high and delicate a nature may equally accord with the republican spirit of our Constitution, and the ideas of liberty and safety entertained by the people." Four years more of practical experience in the presidency found that still standing.

If you are still betting on Dr. Wriston you might like to reflect on the fact that in the final draft of the Farewell Address the paragraph on rotation in office does not appear. Why? Because Washington had not come to believe in it? I do not know. He was working with Hamilton who probably did not believe in it. Had Madison worked up the paragraph merely out of deference to Washington's suggestion or partly because he himself believed in rotation? I do not know. I am not a historian. It is too much for me to weigh and I am not sufficiently familiar with the total political literature of the period and with the various personalities to be competent to weigh that which I have read.

Speaking of Washington in the bicentennial year of his birth Professor Schlesinger said:

"His decision not to accept a third term has become embodied in our unwritten constitution, yet most Americans would be surprised to learn the reason for Washington's abstention. It was not that he thought a third term of office would be undemocratic, but that he was old and tired and anxious to return to the bucolic peace of his Virginia plantation. "While choice and prudence invite me to quit the political scene" he declared in his Farewell Address," patriotism does not forbid it."[6]

So President Wriston and Professor Schlesinger disagree in their interpretations as so many doctors do in so many matters. When doctors disagree it may be that neither can be either right or wrong simply because the facts are too scanty or in too much apparent contradiction or simply too indefinite to make possible a decision either right or wrong;

[5] *Writings of James Madison, vol. 1, p. 566, Lippincot 1865.*

[6] *A. M. Schlesinger, Harvard Graduates' Magazine, March 1932, p. 223.*

one may remain and have long to continue in a state of suspended judgment if one is determined to be scientific.

You are of course by this time impatient with my short and frivolous reference to statistics and with my long and labored discussion of a controversy relative to historical interpretation. You may feel that all this has nothing to do with the place of statistics in child development, and I cannot be sure that it has, except that I should hope that neither the statistics nor the histories of the children would be less accurate or less definite than those we have found in print and on the air these past weeks. And yet I don't know. You see I am no more expert in child development than I am in history. There is little known to me, yet that little is too much for my competency to weigh. If my parable has been so elongated that you consider it quite parabolic, I might get us back to business by raising the question of the present true scientific status of this nature-nurture controversy of yours - this Stanford-Iowa campaign with Terman vs. Stoddard. I have heard competent authority say that we had a Yearbook on the subject a dozen years ago which got us fairly well settled in what we knew and that we have a new Yearbook now which upsets it all. I have heard competent authority say that there have been meetings for the discussion of these matters at which the discussion was mere oratory, appeal to authority, underinterpretation, overinterpretation and misinterpretation of mostly inadequate facts from small or conflicting or indefinite samples, and general misapplication of failure in application of wellknown and appropriate statistical methods. I don't know. I leave it to you, for surely it is a central theme in child development, though it may not be much in evidence on your program for this meeting.

The growth of our knowledge about intelligence tests has been slow, the tests have had to be evolved, they have had to be applied to many and various groups of persons, statistical methods of treating the results have had to be developed, and as all this has gone forward we have reached a stage where special studies of particular problems with special observational set-ups have become possible with some hope of solution. Ars longa, vita brevis. Yet with it all the question of nature-nurture remains unsettled. The situation with respect to personality tests and vocational guidance is less advanced and to many persons seems quite unsatisfactory. In my opinion, which is only an incompetent opinion, we are far from ready even to dispute over the contributions of nature and nurture in the domains of personality and of vocational fitness. It is always helpful to scientific advance if there be found definite physically measurable quantities which bear effectively on our problems, perhaps the work going on in the field of endocrine studies will furnish one basis for a better understanding of some of these developmental problems.

Let me quote once more from Professor Schlesinger's paper on Washington:

> "It should be said, however, that the secret of his greatness as President is to be found less in his ability to originate policies than in his willingness to seek counsel, in his high-mindedness and in the sobriety of his judgment. He was endowed with a goodly share of that stupidity which someone has called God's gift to the English people, a quality of mind which made him deliberate in action,

somewhat inarticulate of speech and always a man of affairs rather than a closet theorist."[7]

Whether you agree with the characterization or not, you do feel, I am sure, that some characteristics other than those now measured as intelligence are of vital importance in men and women. Indeed Chester Barnard in discussing qualities of leadership[8] puts several above intelligence; e.g., vitality, decisiveness and persuasiveness. Have we for any of these or for health an index as good as our intelligence indices with which we could study the role of heredity and environment upon health or the correlation of health with other characteristics? We shall not get far by taking the first health index we happen to construct, applying it to large groups of persons and then trusting to statistical methods to give us sound results independent of the inadequacies of the index. The notion that with enough bad data, good results may be had by the application of enough statistical procedures has been pretty thoroughly exploded by the disappointing and fallacious findings of those who have trusted to this way of life in science.

You have of course some special difficulties in the study of child development which inhere in the fact that development is a serial process, you have to deal with time-series. So does the economist. Unfortunately the theory of time-series is not in a satisfactory state of development even in economics despite the large amount of work which has been done upon it. And it is far from certain that had we a first class method of dealing with economic time-series, we could simply transfer that method to biological time-series. Much has been made by R. A. Fisher of his experimental techniques of randomization; it is hard to randomize a group of children as you would plot out a group of fields for examining the yields of wheat under different treatments of the soil or with different strains of seed. In respect to your time-series the growth process itself seems hostile to the very idea of randomization. From a practical statistical point of view such an elementary concept as the rate of growth during a period has its difficulties because you have to compare two weights or heights or other measurements which are fairly near together and even if there were no errors of measurement the natural fluctuations in weight or the variations of the measures of height due to uncontrollable variations of posture, render the differences of successive measurements tolerably unstable material with which to work.

There are many many statistical methods which have been developed. Some of these are of only mathematical interest. It may be that at some future time they may find useful application. Most of them, however, have already been successfully applied to some sort of data in some fields of science. To collect all these methods would mean to compile a very large volume, or even a series of volumes. It is quite impracticable to teach all these methods to any group of persons, and it would be quite useless to do so because no group of workers in any field, not even one so broad and varied as child development, is likely to need more than a small fraction of them. On the other hand it is more than likely, it is almost certain that for some problems which have already arisen new statistical methods must be developed before complete use of the data can

[7] A. M. Schlesinger, *Harvard Graduates' Magazine*, March 1932, p. 222.

[8] *Harvard Business Review*, Spring 1940.

be made. You have therefore need of well-trained and resourceful statisticians in some aspects of your work. More than these, you must have intuitive scientific personnel widely informed by constant personal experience with children to imagine and to formulate the important problems for investigation and to sense those variables which must be measured if the problems are to be solved.

Very often some group collects interminable masses of data because that data can be collected and then comes to the statistician expecting that he has the magic touch that can turn all this to scientific gold, expecting even that though he knows nothing about the field of inquiry he can by application of routine methods find the significance of the material. Generally speaking that simply cannot be done. Of course if all that is wanted is that data be tabulated and graphed, that means and standard deviations be calculated, or that other formal procedures be applied, that can be done routinely, but that will not elicit the important problems and until they have been elicited they cannot be solvod. As one of our Tercentenary guests from a relatively small and poor country, who had used his invitation to enable him to travel somewhat widely in ours, remarked to me: It is marvelous, this country, you have so many institutions, so much money, so large a research staff in so many places and such collections of data, but I have such difficulty in finding what are the problems on which you work, what are the ideas with which you are working; you just work, work prodigiously; alas, my country is so poor we must have a problem and an idea before we start! It is only fair to say that in my opinion in his country they are so poor that they often have nothing but problems and ideas, no data, and thus remain too exclusively in the field of a priori dialectic instead of emerging into scientific accomplishment. Both extremes must be avoided.

You will have seen that in my opinion the place of statistics in studies of child development, as indeed in many other studies, is a rather modest one, a useful working tool in the hands of persons of competent scientific mind. This is likely to be the case in any nascent field, in any field during its period of early growth - its childhood if you will. Here it is simple tentative exploratory processes that are most fertile. When a field has become well developed with its larger etiology already determined, and great collections of data of known competency to lead to specific results have been made, then statistics may be about all one does need. The job may be very necessary like the calculation of those tables by which the navigator of a ship locates his position at sea, but it is no longer very stimulating as science. You have the satisfaction of working in a nascent field which by its nature is of the highest importance and by its state of development most exciting.

STUDY OF THE NUTRITION OF GROUPS OF CHILDREN SELECTED ON THE BASIS OF NO DEFECTIVE DECIDUOUS TEETH AND HIGH INCIDENCE OF DEFECTIVE DECIDUOUS TEETH[1]

BERTHA SHAPLEY BURKE[2]

The Department of Child Hygiene of the Harvard School of Public Health established ten years ago the Center for Research in Child Health and Development. The Center was planned primarily to provide facilities for research upon well children living at home under normal conditions. These children, approximately three hundred in number, were enrolled at the Center, and of these, two hundred and twenty-five are still being studied from early in prenatal life through a major portion of their developmental period.[3] The oldest children in the group are now ten years of age.

A statistical analysis of the incidence of defective deciduous teeth among children enrolled in the study has been made by Miss Margaret F. Allen, Department of Vital Statistics, Harvard School of Public Health.[4] Following this statistical analysis, a preliminary study of the nutrition of small groups of our children, selected by Miss Allen on the basis of no defective deciduous teeth and high incidence of defective deciduous teeth, was undertaken. The dental data upon which the statistical analysis and this preliminary study are based have been collected under the direction of Dr. Frederick C. Allen of the Forsyth Dental Infirmary.[5]

The groups selected represent Group I, those children who have reached six and one-half years of age with no defective teeth; Group II, those children with the highest incidence of defective deciduous teeth at three years of age; and Group III, those children who had perfect teeth at three years of age but developed the highest incidence of defective teeth by four years of age.

This preliminary study of these three groups was undertaken to discover what, if any, significant differences could be found in these groups of children which might explain why some children were able to go through as much as six and one-half years of life with no defective deciduous teeth, while others of our children showed a high incidence of defective teeth by three years of age. The more significant differences seem on this small number of cases to appear in the field of nutrition or in factors related to nutrition.

In this preliminary study each case has been considered individually in considerable detail. All of the material presented in the charts which follow has been independently collected and analyzed by those of

[1]*From the Department of Child Hygiene, Harvard School of Public Health and the Forsyth Dental Infirmary, Boston, Massachusetts, carried out under a grant from the General Education Board. Preliminary report presented at the Fourth Biennial Meeting of the Society for Research in Child Development held at the Harvard Medical School, Nov. 9, 1940.*

[2]*From the Center for Research in Child Health and Development, Harvard School of Public Health, Boston.*

[3]*Stuart, H. C. and Staff: "The Center, the Group Under Observation, Sources of Information, and Studies in Progress." Monograph of the Society for Research in Child Development, National Research Council, Washington, D. C. Vol. 4, No. 1, 1939.*

[4]*To be published.*

[5]*Dr. F. C. Allen has been assisted in the collection of these data by Dr. J. Murray Gavel and Dr. Philip Williams.*

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us working in our separate fields. The findings have been grouped and are being presented as factual data only. No conclusions are being drawn.

This preliminary study was undertaken on the extremes of the entire group to obtain, if possible, leads for studying our entire group of children in regard to the causes of defective deciduous teeth. This preliminary report will be followed by a more complete investigation of all of our cases including not only the extremes, as shown in these small groups, but all intermediate cases.

The observations on these cases, representing as they do the most extreme deciduous tooth conditions in our entire group of children, are shown in the following charts and justify further study.

GROUPS	I	II	III
Classifications	No defective deciduous teeth through six and one-half ($6\frac{1}{2}$) years of age.	Largest incidence of defective deciduous teeth at three (3) years of age	No defective deciduous teeth at three (3) years of age. Incidence of defective deciduous teeth greatest for entire group between three (3) and four (4) years of age
Incidence of defective deciduous teeth within groups	0	Worst mouth 9 teeth Best mouth 3 " Average 4.5 "	Worst mouth 9 teeth Best mouth 3 " Average 5.2 "
Number cases in each group	11 (One set twins)	12 (One a twin)	12 (One a twin)
Distribution of cases according to sex	Females 4 Males 7	Females 9 Males 3	Females 7 Males 5
Place of child in family group	1st born 9 (including twins) 2nd born 2	1st born 6 2nd " 4 4th " 1 5th " 1 (smallest of twins)	1st born 6 2nd " 4 3rd " 1 4th " 1

A STUDY OF THE NUTRITION OF GROUPS OF CHILDREN SELECTED ON THE BASIS OF NO DEFECTIVE DECIDUOUS TEETH AND HIGH INCIDENCE OF DEFECTIVE DECIDUOUS TEETH

GROUPS	I		II		III	
Number of Defective teeth In parent (Mother)	Worst mouth	25	Worst mouth	32	Worst mouth	31
	Best mouth	10	Best Mouth	15	Best Mouth	11
	Average (1 case not included, no examination)	18.2	Average	22.9	Average (1 case not included, no examination)	20.8

General Average All Groups Together = 20.6

GROUPS	I		II*		III	
Subjective health ratings of children Excellent = 5 Very good = 4 Good = 3 Fair to poor = 2 Poor = 1	Infancy (Birth to 2 yrs.)	3.1	Infancy (Birth to 2 yrs.)	2.9	Infancy (Birth to 2 yrs.)	2.9
	Early childhood		Early childhood		Early childhood	
	From 2 - 3 yrs.	3.2	From 2 - 3 yrs.	2.9	From 2 - 3 yrs.	2.6
	From 3 - 4 yrs.	3.0	From 3 - 4 yrs.	2.6	From 3 - 4 yrs.	2.6
	From 2 - 6½ yrs.	2.8	From 2 - last exam.	2.8	From 2 - 4 yrs.	2.6
					From 2 - last exam.	2.3

*Three poorest children at birth examination in this group:

1. Child with cleft palate (Mother pernicious vomiter during pregnancy).
2. Child - premature 3 lbs. 4 oz. (Mother nauseated 7 mos. of pregnancy).
3. Child "structurally immature" (Mother anorexia last 3 mos. of pregnancy; lost 10 - 12 lbs. in this period).

Prepared for the author by Dr. Edward L. Tuohy from the pediatric records.

A STUDY OF THE NUTRITION OF GROUPS OF CHILDREN SELECTED ON THE BASIS OF NO DEFECTIVE DECIDUOUS TEETH AND HIGH INCIDENCE OF DEFECTIVE DECIDUOUS TEETH

SIGNIFICANT DIFFERENCES IN THE PRENATAL PERIOD

GROUPS	I		II		III	
Amount of nausea experienced by mothers during pregnancy	None Considerable Slight (Mother of twins)	8 1 1	None Active nausea Pernicious vomiter 1 Ill with nausea 7 mos. 1 No data	3 8 1	None Active Nausea Slight	3 8 1
Amount of illness other than nausea experienced by mothers during pregnancy	Totally uneventful Slight illness Placenta Previa	6 3 1	Totally uneventful Course normal except nausea Definite illness (+2 severely ill from nausea) Underweight 25 lbs. at onset	1 2 6 1	Totally uneventful Slight illness Definite illness (One also markedly under-weight at onset)	2 6 4
Amount of milk in diet daily during pregnancy	1 quart (at least) 3/4 quart to middle 3rd trimester: then 1 quart 1 pint 1st trimester; then 3/4 to 1 quart Most of women in this group like milk and include it in their daily diet.	8 1 1	2 - 3 quarts (?) (Data known to be totally unreliable in several fields.) 1 quart (?) Approx. 16 - 18 oz. Under 1 pint major part of pregnancy - 2 improved to 3/4 quart last trimester Many mothers in this group dislike milk.	1 1 2 8	Milk intake in this group more variable (?) 1 - 1½ quarts (?) 3/4 to 1 quart 1 pint - 1 quart 1 pint 6 mos. then 3-4 cups 1 pint throughout Under 1 pint for 4 months; then improved (20-24 oz. - occasionally more) Many mothers in this group dislike milk.	 1 1 1 1 1 7
Cod liver oil or equivalent taken daily by mother	None C.L.O. 1 tbsp. last 6 wks. Viosterol 9 gtts. last 2½ months	8 1 1	None C.L.O. 1 tbsp. last 4 mos. Haliver oil + viosterol last 4 mos. (1 cap.) Viosterol or haliver oil capsule last 2 months	9 1 1 1	None Haliver oil + viosterol 1 - 2 cap. per day last 2 - 5 mos. Haliver oil or viosterol 1 cap. per day 5 months (?) A, B, D cap. per day last 6 months	7 3 1 1

A STUDY OF THE NUTRITION OF GROUPS OF CHILDREN SELECTED ON THE BASIS OF NO DEFECTIVE DECIDUOUS TEETH AND HIGH INCIDENCE OF DEFECTIVE DECIDUOUS TEETH

SIGNIFICANT DIFFERENCES DURING INFANCY (BIRTH TO 2 YEARS)

\- 1 -

GROUPS	I		II		III	
Amount Breast Feeding	Entirely B. F. to 6 mos. or more	4	Largely B. F. to 6 mos. (Mother's diet poor in milk)	1	Entirely B. F. to 6 mos. or more (Mother's diet poor in milk)	1
	Largely B. F. to 6 mos.	2	Entirely B. F. to 3 mos. (B. M. inadequate in amount and mother's diet poor in milk)	3	Largely B. F. to 6 mos. (Mother's diet fair in milk)	1
	Very little B. F.	4	B. F. 1 - 2 mos. (Unsatisfactory all cases)	5	Entirely B. F. to 3 mos. (Mother's diet fair to good in milk)	2
	None	1	In premature nursery (B.L.I.) 49 days - little B.F.	1	B. F. Approximately 1 mo. (Unsatisfactory all cases)	5
			Cleft Palate (Fed with Breck Feeder)	1	Practically no B. F. (Unsatisfactory)	3
			B. F. 16 days (Unsatisfactory)	1		
Milk intake other than breast	Good or excellent to 2 years	8	Good from 3 mos. (B. F.)	1	Good to excellent to 1 yr. Poor 1 - 1½ yrs.	1
	Good or excellent to 1 year (Poor at 18 mos.)	2	Fair from 6 mos. (B. F.)	1	Good to excellent after 6 mos.	1
	Difficulty for 2 short periods only	1	Fair to 3 mos. and again 1 - 2 years	1	Fair to good after 6 mos.	1
			Poor to 3 mos.	2	Poor 1 month	1
			Poor to 6 mos. (2 continued poor to 9 mos.)	6	Poor to fair to 3 mos. and again around 18 mos.	2
			Poor practically throughout	1	Poor to fair to 6 mos.	3
					Poor to fair practically throughout	3

A STUDY OF THE NUTRITION OF GROUPS OF CHILDREN SELECTED ON THE BASIS OF NO DEFECTIVE DECIDUOUS TEETH AND HIGH INCIDENCE OF DEFECTIVE DECIDUOUS TEETH

SIGNIFICANT DIFFERENCES DURING INFANCY (BIRTH TO 2 YEARS)

\- 2 -

GROUPS	I		II		III	
Considering adequacy of B. F. + milk other than breast	Excellent	2	Good from 3 mos.	1	Good to excellent 1 year; poor 1 - 1½ years	1
	Good or excellent	6	Fair from 6 mos.	1	Good to excellent after 6 mos.	1
	Good or excellent to 1 year; poor at 18 mos.	2	Fair to 3 mos. and again 1 - 2 yrs.	1	Fair to good after 6 mos.	1
	Slight difficulty 2 short periods	1	Poor to 3 mos.	2	Poor 1 month	1
			Poor to 6 mos.	4	Poor to fair to 3 mos.	2
			Poor to 9 mos.	2	Poor to fair to 6 mos.	3
			Poor practically throughout	1	Poor to fair practically throughout	3
Appetite	Usually good or excellent		Varied Good many poors		Varied Good many poors ·	
Amount of cod liver oil or equivalent	Good or excellent	7	Excellent largely from 6 mos.	7	Excellent throughout	1
	No data first year; then good or excellent	1	Poor to 3 months	6	Poor to 3 months	7
	Poor to 5 months; then excellent	1	Poor to 6 months	4	Poor to 9 months	3
	Practically none	2	Poor all first year	2	(Rest of periods on above 10 usually good or excellent)	
			Others variable at different periods		None	1

A STUDY OF THE NUTRITION OF GROUPS OF CHILDREN SELECTED ON THE BASIS OF NO DEFECTIVE DECIDUOUS TEETH AND HIGH INCIDENCE OF DEFECTIVE DECIDUOUS TEETH

SIGNIFICANT DIFFERENCES IN EARLY CHILDHOOD (FROM 2 YEARS)

Groups	I (2-6½ yrs.)		II (2-3 yrs.)		III (2-4 yrs.)	
Milk intake 1 quart = excellent 24 ozs. = good 20 ozs. = fair 16 ozs. = poor or less	Good or excellent Fair or poor at 2 intervals Fair or poor at 3 intervals Intake varied widely many intervals	6 3 1 1	Good or excellent Good or fair largely Poor to fair Poor	5 4 1 2	Good or excellent Fair or poor at 1 interval Fair or poor at 2 intervals Poor or fair Poor	4 4 1 2 1
Cod liver oil	Excellent usually Irregularly but considerable None	7 3 1	Excellent usually Irregularly but considerable Definitely poor	8 2 2	Excellent usually Some ? Amount Practically none	10 1 1
Appetite	Very varied ratings		Very varied ratings		Very varied ratings many more poors 3 - 4 years than in groups I and II	
Amount of sweets or excessive starches	Very little candy or ice cream or other sweets Ice cream daily in summer at several intervals (6 of the 11 with one or more periods high in cereal or other carbohydrate food)	6 5	Very little candy or ice cream or other sweets Excessive sweets (Excessive cereal and bread in 1 of these)	7 5	Very little candy or ice cream Excessive candy, ice cream or other sweets especially 2½ - 4 yrs. all or some periods (Excessive bread and cereal in 2 of these)	4 8